# IRON AND STEEL ENGINEER

J. F. KELLY, Editor

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# TENTATIVE PROGRAM

## ANNUAL CONVENTION

AND

## IRON AND STEEL EXPOSITION

### JUNE 7th to 10th, 1926

**Hotel Sherman** **Chicago, Ill.**

### MONDAY, JUNE 7th

9:00 A. M.—Registration.
10:00 A. M.—Business Session.
1:30 P. M.—Safety Code—"Rules for the Safe Operation of Electric Overhead Traveling Cranes."

### TUESDAY, JUNE 8th

Electric Transportation—Yards, Mills, Shops and Factories.

### WEDNESDAY, JUNE 9th

Refractories for Steel Mills.
Standardized Mill Type Motors.

### THURSDAY, JUNE 10th

Electric Heat in the Iron and Steel Industry.
Additions to Rolling Mills at Steubenville Plant, Wheeling Steel Corporation.

### FRIDAY, JUNE 11th

Inspection Trip and Golf Tournament. Illinois Steel Company, Gary, Ind.

The official program of the Annual Convention will appear in the June issue of Iron and Steel Engineer as will also advance copies of all papers to be presented before the technical sessions.

**June 7th to 10th, 1926** **Hotel Sherman, Chicago**

# EDITORIALS

## CONVENTION NUMBER
## JUNE ISSUE
## IRON AND STEEL ENGINEER

The June Issue of the Iron and Steel Engineer will contain all of the advance papers to be presented before the Association of Iron and Steel Electrical Engineers at their 22nd Annual Convention and Exposition being held at the Hotel Sherman, Chicago, Ill. June 7 to 10, inclusive, 1926.

### Transportation

Every engineer who is awake to the developments in transportation need not draw from his imagination for data, facts or figures, to realize that electrical transportation will supersede all other forms now in general use at the present time. The Association with the co-operation of the largest electrical manufacturing companies and the Society for Electric Developments will present to the Iron and Steel Industry, at its Convention in Chicago, a symposium covering this subject which will embrace practically every means of transportation now in use in the Iron and Steel Industry.

Yard switching which seemingly has been one of the greatest problems that electricity has had to overcome is now a reality and in the course of five years will become standard practice. This does not mean of course that electricity will supersede steam in that time but in the course of five years when purchasing motive power for yard switching, electric-driven engines will be favored.

### Electric Heat

The Association of Iron and Steel Electrical Engineers recognized, very early, the great possibilities of electric power as a heating medium and for the past eight years the annual report submitted by the various committees appointed to follow the development in this field have been of inestimable value to the Industry.

Next to labor, fuel is the largest single item of expense in the conversion of Iron Ore to finished steel and during the last ten years, the cost of electric power has increased proportionately less than any other fuel, due of course to the rapid growth of the efficient generating methods now employed.

In order to present the subject from both sides, the committee has secured statements from the various manufacturers relative to the progress made in each group of equipment during the past year, as well as statements from the companies having installations which describe the advantages and economies which may be obtained with the use of electrical heat as fuel.

Arc melting, furnaces, induction furnaces, resistance furnaces (high temperature applications), electric hot tops for molds, roll heaters, low temperature applications, and arc welding comprise the major subjects discussed in the report.

Under Arc Melting Furnaces, a new electric steel melting furnace is described which is in operation at one of the leading steel castings companies. This heating furnace has a number of unique features, many of which are of an entirely new design.

Induction furnaces are treated quite extensively. Heating furnaces for forgings and castings receive a great deal of attention and the statements made by the users of these types of furnaces are very interesting. Electrically heated tin pots, wire drying and annealing, galvanizing kettles, and babbitt pots are also extensively discussed in this report.

### Rolling Mills

The Wheeling Steel Corporation has kindly consented to allow their Combustion Engineer to present a paper covering the additions to rolling mills at the Steubenville plant, Steubenville, Ohio. This paper is of exceptional interest inasmuch as it describes many new developments in steel mill practices. The description covers the boiler plant, gas producers and soaking pits, blooming mill, continuous mill and engines. In connection with the engines, the results of a test conducted with a Four-cylinder Poppet Valve Reversing Uniflow Engine are very interesting, and no doubt will provoke considerable discussion.

### Refractories

Mr. M. C. Booze, senior fellow at the Mellon Institute, University of Pittsburgh, has prepared a paper which is of direct interest to the Iron and Steel industry. Operating superintendents and combustion engineers of the Iron and Steel industry have also prepared discussions which will cover blast furnace linings, open hearth roofs and heating furnaces. Mr. H. C. Siebert, Bethlehem Steel Company; Mr. W. H. Kelly, Bethlehem Steel Company; Mr. W. J. Harper, Donner Steel Company, and Mr. M. J. Conway, Wheeling Steel Corporation, will also contribute in this particular connection.

### Standardized Mill Type Motors

Mr. A. C. Cummins, Chairman of the Standardization Committee, will present the results of the conferences between the electrical manufacturers, the steel industry and the Association of Iron and Steel Electrical Engineers, practically since its inception to standardize mill motors, and when this has been accomplished, it is almost safe in saying that it will have been one of the greatest steps forward in electrical practices in the Iron and Steel industry.

### Rules Recommended by the A. I. & S. E. E., for the Safe Operation of Electric Overhead Traveling Cranes.

The Safety Division of the A. I. & S. E. E., will present to the Association a set of rules which have been compiled by the Safety and Electrical divisions of the A. I. & S. E. E. There are fourteen major rules for the operator and seven major rules for the crane director. These rules, in all probability, will be adopted by the Steel industry in general, and will be used for standard practice throughout the Industry.

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# Rules for the Safe Operation of Electric Overhead Traveling Cranes

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# PROGRAM

## SAFETY CONGRESS

**Auspices**

## SAFETY DIVISION

## Association of Iron & Steel Electrical Engineers

**WEDNESDAY, MARCH 10th, 1926**

**Blue Room—Wm. Penn Hotel** **Pittsburgh, Pennsylvania**

**SUBJECT:**

**"THE SAFE OPERATION OF ELECTRIC OVERHEAD TRAVELING CRANES"**

### WEDNESDAY MORNING, 10:00 O'CLOCK

**EMPLOYING AND TRAINING CRANE OPERATORS—**

A—Safe Crane Operators.
Physical and Mental Requirements, Tests, etc.

B—Teaching Men to Operate Cranes.
Operators to Be Selected From.
1st—Floating Labor or Gang.
2nd—Experienced Operators.
3rd—Course of Training.

### WEDNESDAY AFTERNOON, 2:00 O'CLOCK

**CRANES—**

A—Ladders, Steps, Walks, Platforms.

B—Guards, Falling Crane Parts, Failure of Ropes.

C—Switches, Location of Switches, Manual or Magnetic Control, Hoist Limit Switches, Exposed Current Carrying Parts.

D—Inspection.

E—Lubrication.

F—Fire Hazards.

**RUNWAYS—**

A—Signals.

B—Rules for Workmen and Repairmen on Runways.

C—Approaches to Runways.

D—Rail Stops.

E—Sanders.

**EDUCATIONAL—**

A—Crane Operators Rules.

B—Crane Directors Rules.

### COMMITTEE ON GENERAL ARRANGEMENTS

**C. L. Baker, General Chairman; Managements Representative, Bethlehem Steel Company, Johnstown, Pa.**

**J. A. Oartel, Safety Director, Carnegie Steel Company, Pittsburgh, Pa.**

**A. C. Germain, Safety Director, Minnesota Steel Company, Duluth, Minnesota.**

**W. S. Hall, Electrical Engineer, Illinois Steel Company, So. Chicago, Ill.**

**R. G. Adair, Vice Chairman; Safety Director, American Rolling Mills Co., Middletown, Ohio.**

**J. C. Reed, Electrical Engineer, Bethlehem Steel Company, Steelton, Pa.**

**A. C. Gibeon, Safety Director, Spang-Chalfant Company, Etna, Pa.**

**Walter Greenwood, Safety Director, Carnegie Steel Company, Youngstown, Ohio.**

# *Safe Operation of Electric Overhead Traveling Cranes**

By MEMBERSHIP

*The Safety Congress held under the auspices of the Safety Division of the Association of Iron and Steel Electrical Engineers, emphasized the necessity for standard practices in rules for the safe operation of electric overhead traveling cranes. Every Steel plant in the United States has made, and is making, herculean efforts to safeguard every type of moving apparatus, and as the electric overhead traveling crane is the giant of all types of apparatus that moves, no efforts should be spared to bring about standard practices for their operation which will eliminate any and all existing hazards to human life. The Safety Division of the Association of Iron and Steel Electrical Engineers has made an early beginning and an excellent start in helping to solve one of the greatest problems that now faces the Steel Industry—The Safe Operation of Electrical Overhead Traveling Cranes.*

**Geo. H. Schaeffer:** Members and Friends of Association of Iron & Steel Electrical Engineers:

Since the time our Association was formed, there has been an active movement toward Safety. In fact, our members formed the National Safety Council.

I am safe in saying that there is no steel plant today, of any consequence, that has not installed a safety department. Our Safety Section is managed entirely by a personnel chosen from the most active steel mill safety exponents. They have arranged a comprehensive program, and have chosen that particular line of equipment which, no doubt, has caused the greatest number of fatalities in the industry.

It is our wish that this subject will get your thoughtful consideration. We will appreciate anything that will contribute in any manner to make the "Overhead Electric Traveling Crane" or any other equipment or operation, safer—and thus conserve human life.

It is a pleasure to turn the meeting over to Mr. C. L. Baker, Management's Representative, Bethlehem Steel Co, Johnstown, Pa.

**C. L. Baker:** Members of the Association of Iron & Steel Electrical Engineers and Guests: Our meeting today of the Safety Division, formally opens the first Sectional Meeting this year and we are pleased to greet the many members and visitors present.

It is not my intention to make any extended remarks this morning, as you are all aware that we have quite an extensive program before us today, and in order to hear all the features discussed, it will be necessary for us not to digress to any great extent from our program. However, it may be well to state, for the benefit of our visitors, that the membership of this Association, is made up of Electrical, Combustion and Safety Engineers directly connected with the Iron and Steel Industry.

The Association of Iron & Steel Electrical Engineers was organized in 1907 and from its inception, attracted nation-wide attention in its activities, and it is not in a boastful way that I state that the "Steel Industry was the first to actually recognize the vast humanitarian movement of today," "The Protection of Human Life," and Organized Safety Work in some of its plants date as far back as 1905.

Mr. J. C. Reed, President of the Association in 1908, has the distinction of appointing the first Safety Committee, whose efforts were directed in a national way towards accident prevention work.

The entire Steel Industry of the country cooperated with the Association of Iron and Steel Electrical Engineers in their safety efforts, so that in 1913 this Association invited industry as a whole to participate in what is known today as the "First Co-operative Safety Congress." The proceedings of this meeting were widely distributed throughout the industries of the country and out of this first Co-operative Safety Congress came the present-day National Safety Council. This Association, however, did not cease its safety work, after being instrumental in organizing the National Safety Council, but has ever lent its advice and council in the Safety Movement.

Five years ago, the Electrical Engineers, after thoughtful consideration, organized the Combustion or Steam Engineering Division and the membership are all conversant with the success that has been attained by this important link in the Association. Its activities have grown and are broadening each year, and I am sure there is not a member of this Association or of the Board of Directors, who would for a moment agree to discontinue the activities of the Combustion Section.

Ever on the alert to widen its scope of usefulness, especially to the Iron and Steel Industry, and recognizing the progress that had been made in the electrification of steel plants during the past 10 years, which would strongly indicate that at the close of the next 10 years, practically the entire industry will be electrified, this Association felt that too much attention could not be given to the education of its men, whose duty it will be to see that electrically operated cranes and other electrical machinery is operated safely, and deemed it advisable to expand its activities by the addition of a Safety Division, whose particular field would be to co-ordinate the efforts of the Electrical and Safety Engineers in the Steel Industry.

Such a section does not and will not conflict with any of the activities of the National Safety Council, for it is the purpose of this Division to limit its work to the solution of problems, which continually face the members of this Association in the highly specialized electrical field of Industrial Safety, and at the opening meeting of this Division, which was on the first day of the Twentieth Annual Convention of this Association in Philadelphia September 16, 1925, we were assured of the support of the Steel Industry and co-operation of the National Safety Council in this movement.

Today, we are to discuss, probably the most outstanding safety problem that the Electrical Engineers and Superintendents have to face in steel plant

*Presented at Pittsburgh, March 10, 1926.

operation, that is "The Safe Operation of Electric Overhead Traveling Cranes."

**W. Greenwood:** Starting with the assumption, efficiency and low accident hazard accompany each other, considering first the mental and physical qualifications of the man, selection should be made from men having general knowledge of mill operations, particularly the department they are to be assigned to; also their desire to acquaint themselves with the details of operations. We can realize the importance of having a craneman in a machine shop, any mechanical department, or any other department, whose judgment tells him the importance of every move, the approximate weight of material to be handled, the value of the attachments used in connecting the load to the crane tackle, and how far he should go in the matter of lifting excessive loads; without being obnoxiously combative, having courage to protest when told to do something with his crane that, in his judgment, probably would result in trouble, damage to equipment and possibly injury to person; absolute control when raising, lowering or moving short distances to place or remove a part of any equipment. Then again, in an open hearth department, where a 150-ton crane may be required to carry loads varying in weight from that of a shovel to the full capacity load. With the power of observation accompanied by zeal a craneman here can anticipate the order of his work, like distributing dolomite, sweeping up scrap, carrying ravels to and from shop, stoppers to ladles, stopper rods to shop, changing cinder pots, pulling necks, placing spouts and doing all the numerous jobs that are practically routine work. Again, in the mold yard, the work is more or less routine, much of it orderly, most of it a repetition of work whether orderly or not. There are cinder pots to dump and replace on cars, there is cinder to break and load on outbound cars, scrap to sweep up, molds and stools to handle, unload and again pick up stock if any should be stored in the yard, and many other odds and ends of jobs like transferring loads, etc. In the rolling department the crane is practically a standby piece of equipment. It must promptly answer the roller's and the millwright's calls, and as opportunity permits must do the routine work such as handle cinder cans, handle billets for the weighmaster, and parts for electricians or carpenters.

Of course cranemen are at all times subject to orders, either expressed or implied, but excepting on particular jobs, they get their orders from almost all of the men working in their department. Where two or more orders are given by men not particularly authorized to give them then judgment must guide as to which order should be executed first. Whether we will it or not, the craneman must possess authority within some limits. In many respects their responsibilities are similar to those of locomotive engineers who, under certain conditions, refuse to act until their objection to doing so is removed. Likewise, they take orders from others than the conductor, who is supreme in command. Notwithstanding the superior requisites possessed by good cranemen, they are disposed to change employers, whether for better pay or better working conditions. Probably there are no other employes that handle electrical equipment in mills whose good and long continued service should be more appreciated than that of crane operators. Possibly more might be done in many cases than is done to show appreciation of them. A craneman who cannot leave his controller should not be annoyed by escaping fumes from a locomotive parked unnecessarily below him. Since he cannot keep warm by bodily exercise, he should not be compelled to suffer from cold. Anything that has a disconcerting effect should be avoided if no excuse is to be offered for his not being alert in both mind and body, and unless he is continuually alert his machine is liable to mishaps that might be avoided.

The methods for teaching men to operate cranes naturally must be as various as are the local conditions in different plants and departments of plants. In the first place we should presume the prospective crane operator has already acquired some knowledge of mechanics and its application to electrically operated equipment. Without such knowledge, the chances for becoming a good and successful operator are quite remote. Therefore, the next thing to consider is, how much knowledge of mechanics or their general principles he may already possess before instructing him in the details of operating a crane. A crane operator should be classed as an electrician of some degree. He cannot be one of any degree without some general knowledge of mechanics. Employers could carry on school work to educate and fit their employes for higher responsibilities. It has been tried and before these discussions end we probably will hear much concerning the success or failures that resulted. With a full complement of other qualifications the education for detail operation of a crane can be acquired only on a crane under the guidance of an experienced operator. How much time should be given to this should depend on the aptness of the beginner, but he should remain under the instructor until he has demonstrated he is entirely competent. Whether or not men are educated in mechanics by their employers, crane operators should be selected from men having some such education. It is reasonable to assume that, with the present-day opportunities like classes in the Y. M. C. A., correspondence schools and other special schools for adults who have been lacking in early opportunities or have neglected them, the person who wishes for advancement is not very ambitious if he will not help himself to the necessary education instead of depending on a method that is incomplete and more or less unreliable.

So far as training goes in the present methods for qualifying crane operators, we think nothing more can be asked from most of the employers. In how far they have failed to see that the other requirements here outlined are possessed, we have no opinion. It is a fact all schools give diplomas to some scholars that are never efficient in special instructions or any other. It cannot be denied that the efforts of employers to instruct must sometimes fail.

In regard to selecting timber for cranemen from a particular class of employes, particularly from a class that constitutes the lowest strata of employment, there should be no objection to so doing provided, of course, care was taken to see that all necessary qualifications except training to operate a crane were possessed. It is not uncommon to see persons possessed of these qualifications enter into mill life through this principle and many times the only available opening. With the step-up system of promotion generally adopted in the plants of the

iron and steel industry, it is in some measure obligatory to select crane operators from the less desirable employment that does not receive as much wage. From many points of view this seems to be the best practice. Men who work in the line crew and repair crews have better opportunity to acquire knowledge of operating conditions than men whose education is purely academical. Repairmen naturally get to know more about cranes and the method of operating them than does any other class of employes.

In discussing the next division of our subject, it seems reasonable to say that, everything considered aside from qualification, preference should be given to employing experienced operators. Qualifying operators is more or less expensive, so why not make use of the stock on hand instead of allowing them to drift into other employment, where their training to operate cranes will be of no benefit to anyone? No operator is ever so proficient he cannot learn new tricks or better understand established principles, so the longer and steadier his employment is, the more proficient he should become.

In discussing the last division of our subject, we can only point out the principal points to be covered. He should be instructed in the application of the safety rules and the importance of strictly following them, the capacity of the hoist or each of the several hoists, the method of applying and the office of each of the several brakes, how to proceed in case a brake fails when lowering and there is danger of any kind from lowering the load, the importance of permitting the hoist limit to come into operation only when trying it to see if it is in perfect order, how oiling should be done and inspection made, how to make reports of defects and how to get them corrected, how to proceed when abandoning his crane at times when there will be no further work for it and there will be no relief operator to come on. He should be thoroughly drilled repeatedly in the operating and safety rules until assurance is felt that he fully understands and is efficient in executing them. Further education is contained in the rules and bulletins that are placed before him, and all that is needed to master the details for safely and efficiently operating a crane is to get busy and absorb the instructions that have been given him, which should require but a few days if the effort is earnest.

The hazard connected with the operation of cranes has been much reduced by elevating the standard of construction. It probably will be further reduced as finances will permit, replacing inferior equipment with such as will comply with latest approved standards. To replace any considerable group of cranes with more modern ones would be a staggering proposition for any corporation. While such as are in use must still remain, our efforts must be directed toward safely operating them. In doing so we should be extremely careful about making useless suggestions that might influence industrial commissions in making rules that would be an annoyance and a burden to users and would accomplish no beneficial results. We must not lose sight of the fact, the user is much benefited by accident prevention work, and is always ready and willing to go along with any feasible, intelligent and efficient proposition.

In this discussion we have outlined quite a high standard that crane operators should be selected from. It probably is very nearly approached by many operators now in service. Some may need elevating. As to how closely such a standard is to be adhered to in the making of new operators is a matter for the employer to decide.

**R. G. Adair:** I have not prepared a paper on this subject, but I might tell you what we are attempting to do in the selection and training of crane operators in the hope that it will prompt wide and frank discussion on the subject. Like the Carnegie Steel Company, we have a special eye and ear examination for crane operators and men who are hoping to become crane operators, in addition to the regular physical examination upon entrance to the Company. Although I am unacquainted with the requirements of the ear test, our eye test demands normal vision and in the case of imperfect vision, full correction by glasses. In our plan this examination is obligatory once a year or more often if the doctor desires. Once a cranemen successfully passes the eye and ear test he is given a card so stating and this card bears the date he is expected to return for a subsequent examination.

Some ten years ago, we were experiencing many accidents that could be traced to the operation of cranes and when those most concerned got into the matter, it was found that a more careful selection of the type of crane operator was imperative. Many of the men on the job at that time were of the youthful, reckless, devil-may-care trend of mind who paid little heed to the hazard to which they subjected the large number of men on the floor. As fast as possible, this type of accident maker was replaced with men of a more mature and conservative nature and with the change came more efficient operation and far greater safety until today it is a rare occurrence that a cranemen can in any way be connected with an accident to the men on the floor.

With the careful selection of material for this job, it also became apparent that a more enlightened training program was needed and the system we employ may be new to some of you. Our source of supply comes almost exclusively from operating men, often crane followers, who have served their time on the floor. Being familiar with the floor work as hook-up men, when transferred to a crane operator's job, they are familiar with the crane movements, the essentials of a safe hook-up and perhaps more important than all, the problems and viewpoint of the men who follow the crane. When a man decides that he would like to become a crane operator, he naturally speaks of the matter to the electrical foreman in that section and if the electrical foreman is satisfied that the applicant is suitable material for an operator, he directs him to the Employment Department, where he is again sized up as to suitability. If satisfactory to the Employment Department, the applicant next calls on the doctor and if found to be physically O.K. for the job, he is issued a crane practice card by the Employment Department.

This card entitles the applicant to go into the crane cab at any time and to observe and practice under the supervision of an experienced operator. Neither the practice card man nor the crane operator are paid additional wages for this arrangement. When a practice card man becomes sufficiently skillful and demonstrates to the satisfaction of the elec-

trical foremen that he is suitable material for a crane operator, the electrical department asks for a transfer of the man to the electrical repair gang as a wireman's helper. Here he becomes still better acquainted with the practical aspects of electrical department work and is available as an extra craneman. This is also the logical time for the embryo crane operator to take advantage of classes in electricity at our Training Department and thus improve upon his general knowledge of the subject.

Such a training program would be practical only when there is close cooperation between operating and electrical heads, but when operating superintendents realize the importance of good crane operators, as they usually do, there is little hesitancy on their part to transfer their men to the electrical department, for such important jobs.

This system of careful selection and training program has, we feel, not only greatly reduced our crane hazards but also done much toward establishing a more efficient and trustworthy organization of crane operators.

**C. B. Auel:** I have considerable hesitancy in participating in the discussion, because I feel that our work along this line is largely a repetition of your own practices, and I feel doubly so since listening to the several speakers. We have approximately 175 cranes in our main plant at East Pittsburgh, and my remarks will be confined to this plant. Our cranes range from the floor operated cranes to 50-ton cranes; being therefore of all sizes, and further, all kinds, and I might even add, vintages. Our crane operators range in age from 20 years to 57 years; the average being a little over 32. In point of service they embrace not only the new man, but what we call our junior and senior veterans; men who have been 10 to 20 years or longer in the service of the company. Our work is made even more complex at the present time due to a considerable number of our departments undergoing remodeling owing to our products becoming constantly larger and larger.

In taking on new men as crane operators they are first interviewed by our employment department. If favorable conclusions are reached with respect to an applicant, he is further passed on to our crane department where he is examined at greater length and in detail. If this department's conclusions with respect to him are likewise favorable he is sent to our medical department and examined there in much the same manner as just outlined. I might state that fears expressed by a great many people some years ago that workmen would object to physical examination, has not been borne out. Furthermore, they are even willing to submit to vaccination, which is something recommended by our state department of health, and I take this opportunity of urging it on all those who have not introduced it, as carrying out the wishes of the State Department of Health. The strongest objection made to a physical examination is that it is sprung unexpectedly on a great majority of fellows who would appreciate an opportunity of cleaning up a bit for that purpose, and I can readily see that the objection is a valid one and we should endeavor to go about meeting that really valid objection. Assuming that the applicant has passed all the preliminary requirements, he is again sent to the Crane Department, where he is posted not only on the general rules of our shop but on his work in detail, and furthermore, is provided with a printed copy of our crane rules in addition to other printed matter. These rules pertain more particularly to cranemen and their helpers, and if anybody is desirous of a copy we shall be glad to supply such on request. Included in this book of rules, we have set down safe loads for chains and slings. I feel particular attention should be given to posting crane operators on safe loads for a sling, chain, cable, or rope; so that notwithstanding it is not the first province of a crane operator to see that the loads are lifted properly, nevertheless, having some knowledge of whether or not a load has been properly fastened, it would make an additional step towards safety; and we know, notwithstanding, our best endeavors to provide safe chains and slings of one kind and another, there is still an element of uncertainty in the material itself, which we cannot guard against. Within the last two weeks we had two lucky accidents: A link of a chain actually broke after the load had been transported down the aisle and one end actually deposited on the floor, the other end being, fortunately, within a few inches of the floor. In the other case a link actually broke in two with no load on it whatever. And so I say, it seems to me this organization could do a splendid work in advocating the teaching of the crane operators themselves the value of watching the loads to see whether or not they are properly fastened or trussed up preparatory to lifting. For example, do all crane operators know the strength of a chain or cable varies with the angle of load, depending upon whether or not the angle is 30°, 40°, etc.

We endeavor to put our new men at work on our safest or least hazardous cranes. For the first two or three days they are simply in the cage with a crane operator and are given full opportunity to become familiar with the lay-out of the floor, after which they are allowed to operate the cranes themselves under the guidance or eye of the regular operator. If the work falls behind, the operator replaces the man until the work has been caught up. The foreman in charge of crane operation visits at unexpected intervals, the location of a crane with a new operator and observes for himself whether or not the new man is coming along satisfactorily. At the end of the first couple of weeks, the foreman or his assistant enters the crane cage and spends some little time with the new man to make sure that he has advanced to the point where it will be safe to trust him alone. If so he is then allowed to operate the crane. If not, his instructions are continued for a further period. The new crane operator is also required almost as the last thing in his period of instructions to read out loud our book of rules.

Of the crane operators, about 20 percent are taken from our shop floor, in contradistinction to what Mr. Adair told us. On the other hand we transfer to the floor about 40 percent; and, of the men we hire, our experience seems to show that the new but inexperienced man whom we teach will stay with us a considerably longer period than will the experienced craneman whom we hire. So that it would seem to indicate that the experienced craneman who applies to you for a job is more or less of a floater. Promotion is made from one class of crane to another, or from crane to the floor, and other

things being equal, preference is given to the men longest in point of service. Our night operators are paid a 10 percent bonus and all of our operators are paid for an extra quarter of an hour's time for keeping their cranes in proper condition, not only with respect to repairs, but with respect to cleanliness. In general, our labor turn-over does not appear to differ with respect to cranemen from that of our other departments. We have what might be termed a supply squad, consisting not only of extra men to take the place of those absent from work, but those who have been moved on from cranes to the floor and who are readily available in case of emergency, and the training of these men continues, not to the same extent as our regular crane operators, but sufficently so that they can be called on by us in time of emergency.

One matter that I want to place before this meeting, and it seems to me this organization could take it up to good advantage. Cranes in some cases have a control that is operated by a forward and back motion. In other cranes the control is operated by a rotating motion. In canvassing our work some time ago, it was a 50-50 propostion with our cranemen whether they had one type of motion or the other. But I submit, if, for example, it is desirable in a punch shop, to have presses operating by belt throw the lever the same way, there should be similar uniform practice in the operation of cranes, because every little counts in accident prevention. It is hardly fair to put a craneman who may have been familiar over a fairly long period of operation on a crane with control moving in a certain direction, and then change him to a crane with a control moving in a different direction.

I have nothing further to add, except to emphasize two points touched upon in my remarks, viz.; the teaching of cranemen to a greater extent than has been done the safe loads on slings and chains depending on angles; and the moving towards standardization of control operation.

**G. H. McClain:** There are two things I would like to get a little comment on. According to my reading of the code covering the operation of cranes, a boy 18 years of age is permitted on a crane as an operator. There has been some discussion lately as to the feasibility of these limits, not from the code but from our own practice. I would like to hear from those who have had experience that way.

Another point: In steel mills there are times when there is not a crane operator out; say at 2 o'clock in the morning, or Sunday afternoon, when the millwrights need a man. We have developed a system of substituting crane operators that must be examined and taken care of in the usual way, and registered as such. I would like to know how somebody handles that unusual condition.

**John James:** A man with two years' experience tion of men there is some objection from them. But I dare say the Carnegie Steel Co. informs applicants of this examination. One thing struck me forcibly since coming here and that was the placing of the responsibility upon the craneman. I dare say if I went back and told those boys of the men who are spending their time here in the interest of cranemen they would be pleasantly surprised. From this movement I hope cranemen will land in the position where they should be. Up to three years ago he was given little consideration, but the managers of industrial works are beginning to realize what depends on cranemen. I will say the grade of men is improving, but I don't like the idea of anybody placing the responsibility upon the craneman. The Carnegie Steel Company has rules in crane cabs as to what cranemen shall do. It is up to him to obey the signal. The crane foreman is the man who should be responsible as to whether there is a bad link in a chain—and, incidentally, chains with the Carnegie Steel have been going out of use the past 20 years. They are using steel cable, which is more reliable than chain. I have been handling cranemen for twenty-five years and I believe we get the best service out of young men after they are 20. Eighteen is a little bit young. If you get young men you can make cranemen out of them. After 35 they are nearly impossible as crane operators. Please don't try to shift the responsibility on cranemen. I like the rules of the Carnegie Steel Co. showing that the man in the cab should obey instructions of the man on the floor. So the man on the floor should be responsible for conditions on the floor and the man on the floor knowing his business, it improves the craneman's work to a great extent.

We train our men in Homestead in a manner as follows: We take a man and if he has no experience we put him with a man around the mill to get acquainted with locations and general conditions, then we send him with a man who knows his business; watch him until we feel he is thoroughly competent of operating the crane.

In regard to the condition of millwrights wanting a man at 2 o'clock in the morning, as stated by men in other plants, we are always prepared. A system of having men ready to do the job is well worked out in the Carnegie Steel Co., at Homestead. Conditions of the Homestead Steel Works have improved wonderfully in the last twenty years, with rapid strides in the past five years, for safety, and we are proud of conditions at the Homestead Steel Works.

In our department we have about 100 cranemen, that is, directly under my supervision, and we always have a list of cranemen as ordered for any kind of work. If there is not a man ready for emergency at 2 a. m., it is not the electrical department's fault; it is the manager's fault who failed to prepare for that condition. If such a condition arises we have electric repair man, motor inspector, helper, etc., who are able to take care of those extreme conditions

**W. W. Hall:** I would like to get an opinion from Mr. James as to what he considers a capable crane operator as to the mechanical condition of the crane?

**John James:** In regard to the physical examina- should be able to give you a fair idea of the mechanical condition of any crane. If not, he belongs somewhere else.

**M. M. MacDonald:** The gentleman who spoke expressed a sentiment that is my own to a certain extent, but I think possibly it needs to be carried out and given some explanation and detail, in regard to bringing the responsibility up to the craneman when there are defective chains. When he is requested to pick up a piece that lies on the floor in excess of the weight for that piece of equipment; how do you handle that in your plant? How much responsibility do you put on your craneman? Do

you tell him, there is a hook-up man on the floor, what he tells you to do you must do? Do you tell him that, or just what do you tell him in regard to orders?

**John James:** His orders are to obey the instructions of the man on the ground. He is acquainted with the capacity of his crane and his orders are that he shall give service at all times. Under extreme conditions only we allow the operator to dictate to any other department or men on the floor what shall be done. Understand there are ground rules and crane cab rules. The ground man has signs and directions he should give to the crane operator. The capacity of the crane is put on the crane cab or somewhere you cannot mistake it.

**M. M. MacDonald:** If it were a 50-ton piece and he had a 25-ton crane would he go ahead and hoist it up?

**John James:** We don't allow him to dictate to the man on the floor, or man in charge of the work to be done.

**M. M. MacDonald:** Don't you tell him to use judgment as to whether he be wrong or right?

**John James:** We would not expect a man to be so lacking in judgment as to double the capacity of his crane.

**M. M.MacDonald:** What we tell him is this: This is the capacity of this crane; if you question that load is not right, hold your crane right there, or get down and get him to make it all right. If he is day-superintendent in that department there may be an emergency there; therefore, you want somebody else in higher authority. It seems to me under your system he is to hook-up and go ahead and do things regardless of his own judgment.

**John James:** We don't send cranemen out with the understanding that he should question everything that comes along, because we found that will not work. We found that men must be sent out to obey instructions of the man or men he is working for. But we do expect him and tell him to use his judgment in extreme cases only, because we have found, sorry to say, some very competent men, who have induced him to do the extreme.

**J. D. Scully:** A safe crane operator must necessarily be capable of exercising good judgment. Practice has shown that the hook-ons and other workmen depend upon his good judgment in handling the crane to avoid accidents.

He should pass the physical requirements of the State Code in order to conform to the law. However, experience has demonstrated that the very best and most careful crane operator can be more or less physically disabled. An artificial limb need not stand in the way of a man being a very efficent and a careful operator; it usually acts as an incentive for the man to overcome his physical handicap by a closer application to his work and a better appreciation of his position, which, on the whole, tends to make him a contented and a safe operator.

Crane operators should be mentally the equal at least of street railway motormen, and should be capable of reading and writing the English language. They should be able to converse intelligently on ordinary topics.

A good craneman is one who is even tempered, has the ability to cooperate with the floor men, is contented with his hours of work and wages, and one who will cheerfully endeavor to follow instructions. A craneman having the above mentioned qualifications will be found to be also a safe operator.

It cannot be emphasized too strongly, the importance of the crane operator's ability to cooperate with the floor gang. All crane operators should be urged to make every effort to be obliging and considerate of the men who follow the crane. Lack of personal contact between the crane operator and the floor foreman and the hook-ons very frequently causes misunderstandings which results in accidents or the dismissal of a crane operator who otherwise would make a good employe. Test cases have been made where some particular floor foreman was dissatisfied with the crane operator, and, at the suggestion of that floor foreman, one of his most trusted and best liked men was given the job of operating the crane. After several months, the floor foreman had the same complaint to make as before. Lack of personal contact had made the foreman and crane operator suspicious of each other, and one would not cooperate with the other.

Crane operators can best be selected by the cooperation of the Employment Department and the Electrical Department. A competent official of the Electrical Department, who is thoroughly familiar with the various cranes and the particular class of work consigned each case, is best fitted to select Crane Operators. The class of work and the environment of one location may differ from that of another, and a man who would not get along or would not make a safe operator for one crane, may be entirely satisfactory on another, provided care and good judgment has been exercised in placing him where he can work to the best advantage. Crane operators should not be selected from the so-called floater, as experience has proven that this type of operator as a rule is undesirable and hard to manage. It is not necessary to employ experienced crane operators as new men can be taught to operate within a reasonable period, and, in the majority of cases, the operator will become skilled in operating the crane long before he is familiar with the various phases of the work to be performed by the crane. Applicants for position as crane operators can be selected from most all walks of life. An effort should be made to keep a high standard of crane operators, and, in order to accomplish this and reduce the labor turnover, the following points have been kept in mind in their selection:

Applicants should be of a good moral character and should have a good reputation in the community in which they live, and should be, if possible, personally known to be such by party selecting applicant, or should be vouched for by responsible parties. As a rule dependable crane operators can be relied upon to recommend others who made good operators. It is a good rule to select operators from the families of trusted employees. This tends to promote interest in the department and loyalty to the employer.

Crane operators should be trained under the supervision of a competent and careful operator. The length of time required to train operator varies with the man and job. To operate efficiently the operator must, in addition to mastering the crane learn the floor work so that he can anticipate the next move and have executed the work without delay. After

the operator has completed his course of instruction, the operator under whom he was receiving instructions should fill out a form provided for this purpose, which form should be signed by both men and kept for a record.

On hot metal cranes, a special form can be used, which is also signed by the turn foreman after he his personally observed the manner in which the new operator handles the crane. This form can also include the designated extra operators who may be called upon occasionally to operate. In this way a record is kept of all operators who are permitted to operate the hot metal cranes, and this avoids the possibility of an unqualified and inexperienced operator being assigned to operate a crane where there are special hazards.

Crane operators should inspect their cranes and test the limit switches once each turn and report immediately any defects. In order to insure the operation of safety devices, the operators should be trained to not operate the crane when any safety device is inoperative.

In addition to the regular maintenance crew, there should be a general crane inspector, whose duty it is to make regular inspections of cranes and report on a form provided for that purpose, a copy of his report to go direct to the turn foreman and the original to pass over the desk of Electrical Superintendent, or his assistant, who personally notes the report and check on items of importance, which are referred to parties responsible for upkeep of cranes.

Portable rail stops that are secured to the rail by means of a drift key can be used for limiting the travel of cranes, but should be used only as an extra precaution. In addition to the rail stop, a flagman or look-out should be stationed in the crane cab to warn the operator when approaching close to the stops.

A standard set of signals should be adopted and enforced.

Workmen on crane runways can be protected by observing the following rules which have proven to be effective:

It is against the company's rules for any employee to go on or dangerously near any crane runway unless the electric department has been previously notified and the men protected by flagmen, rail stops or "LOCKED OUT SWITCHES" as per special instructions to cranemen. Cranemen upon observing any violation of this rule must shut their crane down at once and notify their foreman.

Crane operator rules should be posted in crane cabs and at the foot of all ladders and stairs leading to cranes.

A good plan to get information to all crane operators and keep before them important safety matters, is to have a loose leaf file in each crane cab, and send out periodically multistamp copies of safety instructions, near or major accident reports, or any of the regular crane rules. In this way they can be constantly reminded and kept informed in matters of safety.

**W. F. Dittmer:** I would like to ask Mr. Adair if, under the system he described as being in practice at their works (The American Rolling Mill Co.) crane operators taught applicants free?

**R. G. Adair:** Yes; they receive no additional wage as it is done in connection with the regular operations on the craneman's eight-hour shift. It often occurs that the practice card man is a personal friend of the crane operator and has been induced by the crane operator to apply for the practice card. In this case the crane operator probably has an additional incentive to see that the instructions given are of high standard.

**J. K. Witherspoon:** Speaking of getting a man in emergency to take care of breakdown. There are very few mills but what has cranemen to take care of constant operation. We have 17 cranes varying from one to eighty tons, and we make a schedule and this schedule is given to the night turn electrical foreman. He takes care of this and we have five cranemen at night. Don't have a spare craneman but rely on the regular cranemen. You can take ladle craneman or whatever craneman to handle the emergency by putting him on this crane. This man is prepared to handle the crane. The night turn master mechanic or millwright knows where to call for a craneman. We do not allow millwright or anybody who is not experienced with cranes to go up in cabs, and I think it is poor policy to allow anybody to go up in a crane, even though he has stood physical test, unless he has credentials to do so.

A question I would like to bring up for discussion is responsibility of cranemen, the hook-on and superintendent of the department and relation to the head of the electric department. In most cases the electric department takes care of emergencies. Just the responsibility that does rest on that phase. In our plant the craneman is 100 percent responsible for any load he hooks onto, and also the hook-on is 100 percent responsible, and the superintendent of that department we hold him responsible, because in the line of his work he should be expected to be there to see that it is handled properly. The craneman should be held 100 percent and every man that deals with that 100 per cent. We have never had any serious accident owing to dropping a load or breaking a chain. We have our cranes inspected once every day. We pick our cranemen and pick very thoroughly. We have trained many men and turn down more than we take up. Foreign people should make good cranemen.

In regard to controls with different movements on the controllers. We see that the cranemen thoroughly understand them and don't get mixed up. We have two or three different types of controllers that have different movements. I feel a lot of accidents occur from a boss coming along and saying, "Jim, you go up and operate that crane." I feel that a man who runs a crane is responsible and has lots of lives in his hands.

**M. M. MacDonald:** I would suggest that a questionnaire be sent out to the various departments of this organization, which is a representative body of the steel industry, and then results could be tabulated and we could arrive at a decision as to what constitutes safe practice in crane operation.

**C. L. Baker:** That is the idea this division is working along. We are having prepared safety rules for crane operators, and this is in kind, I am sure, and we are going to send that out to the entire membership of this organization when it is perfected, so that they can see what the majority, with the

advice of the safety engineer and the electrical engineer, think about this crane problem.

**G. H. McClain:** I would like to add a few words on this subject of our substitute cranemen. They are examined physically and they are taught and then approved by the superintendent of the electrical department. There is a card goes on file showing the man has also been approved by the safety department. In these days of competition the cost of iron and steel must be kept down. There are times when it is necessary to make two or three lifts, and in the event that occasion arises there usually is a man in that department trained and authorized. The code says nobody but a crane operator shall make the lift.

**John M. Sandel:** I think you will all agree with me that the fact that since there are so many here and one whole day's session is entirely devoted to safety, that safety is an integral part of the operation of electrical cranes. Another proof is the statistics that have been gathered on crane accidents. I have with me figures of the accidents that have occurred on cranes and derricks of all kinds within the Commonwealth of Pennsylvania during the year 1925, and the total is 3,675, of which 82 were fatal accidents. That is a large number. I wish to say, if anyone is interested, I have the figures which the department has collected for the iron and steel and metal trades industries separated by various counties where they have occurred.

Two things of importance in connection with operation of electric cranes is the safety and preparation for handling of loads by the floorman and making inspection of slings and cables used in hoisting. Unless you have provided the crane operator with a good safe sling and secure safe preparation of your loads in the handling of materials by cranes, it is going to be productive more or less of accidents. The Department of Labor and Industry has issued regulations regarding the operations of electric cranes, but it is evident that those regulations cannot cover everything in connection with crane work. It is possible to take care of mechanical safeguards, by regulation, but the many phases of operation which are under control of the human element are not possible to be regulated. It is entirely up to the industries to see that safe practices are promulgated and enforced. The department will be glad to go into a plant and help any organization in special safety problems. We feel we will go further in reducing accidents throughout the state of Pennsylvania by co-operating in that way rather than by going in with a "big stick" and forcing safety down your throat. The number of times it has been necessary to take official action with the "big stick" to secure safe conditions has been very few, due to the fact that the safety movement has always been a co-operative effort and that we can get co-operation without difficulty. I want to invite you to let the department know when you feel that we can be of assistance. We are glad to help in preventing accidents.

**A. J. Standing:** The feasibility of educating cranemen and directors or floormen by means of rules however clear and explicit presupposes the ability on the part of the men to read and understand the rules to the degree that they are able to automatically follow them in their daily operation. This condition can only be realized after repeated efforts have been made by the foremen to check up on the actual understanding of the operators.

We approached this feature at Bethlehem by having the set of rules delivered to the cranemen by the foreman. The craneman read the rules or had them read and explained to him, then signed the rule card and returned it to his foreman, who in turn turned it into the Electric Department office, where the signed card was checked against the craneman's data card on our files., The rules were then returned to the craneman by the foreman.

The crane directors or floormen do not come under the same department as the cranemen, but their rule cards were sent out through their departmental organization.

What have we accomplished?

We have gone through a formal set of moves that mean little or nothing unless the foreman and crane repairmen keep everlasting after the operators who are known to be lax in their observance of the rules and usual safe practices when operating their cranes.

One of the outstanding points that must always be born in mind in behalf of crane operators is the confusion, anger, and subsequent recklessness caused by the shouting and bawling at an operator by some one not regularly directing the work. This is especially likely to happen in cases of emergency breakdowns or when there is a conflict in the demands for crane service by two distinct parties as for instance two mill foremen or even superintendents.

Try and get the craneman's viewpoint, both physical and mental, and you must realize that at times he may be absolutely at a loss as to what is required and yet the insistance of someone in authority demands action, with the result that a false move causes an accident for which the crane operator is blamed by the very man in authority who was the real cause of the confusion and misunderstanding and who either leaves things in a mess or has the operator replaced to protect his own actions.

The problem of enforcement of rules and penalties for infraction thereof depends to a certain extent on several factors, viz:

Importance of the job.
Record of the man.
Supply of cranemen.
Value of the job and its desirability.

We will all admit that in a fully operating plant we must use some judgment in the handling of operators, especially on important jobs.

The desirability of the operator helping on repairs depends very much on his characteristics and adaptibility along repair lines; as a rule he is of more value in the cage for tryout and necessary crane movements than he is on actual repairs unless he is like our old stripper operators at Saucon who nurse their two cranes and make the repairman keep them up to the top operating condition at all times. The operators in this case are our best repairmen on those two cranes, but that case is unusual. These operators fill all their own vacancies among themselves and in general they see that the steel is stripped.

I feel that the spreading of rules and information among the operators and floormen unquestion-

ably has very great value and the reaction will inevitably show itself in reduced accidents, chargeable directly or indirectly to crane operation throughout the plant.

We have started another safety feature on our cranes in Saucon plant and that is the use of padlocks on switch clips which enables the crane operator to lock his switch open while he is oiling or packing his crane or going over the trolleys and makes him safe from anyone getting into the cage and trying out the crane.

We have been using this padlock scheme on all ground switchboards for some time and find it works out very satisfactorily. The locks are stamped with the man's name and he is provided with a key for his own lock; the duplicate is tagged and held in our office.

**J. S. Murray:** All our crane operators are employed by the Electrical Department and we employ only experienced crane operators, unless we find it absolutely necessary to do otherwise, in which case we train inexperienced men for a period of time with regular crane operators. These inexperienced men are trained without pay in a manner similar to the methods outlined by Mr. Adair, of the American Rolling Mill Company.

We select men who are white, not less than 18 years of age, nor more than 45, and American, if possible. All men, of course, have to pass a physical examination within 24 hours from the time they are hired, and are under the direct supervision of the motor inspector while they are being trained. The motor inspector is also the judge as to their proficiency in operating cranes before they go on as regular cranemen. We also have extra cranemen in the inspector's gang and also on the line gang to take care of emergencies. We have certain fixed rules for governing operation of traveling cranes posted in each crane cab, similar to the sample sent to this association recently, and we are also considering adopting rules for crane followers.

### Cranes

We use steps on all our traveling cranes instead of ladders wherever possible, but had ladders installed on all approach platforms. All crane ropes are inspected once a week and record made of the condition on motor inspector's reports. All our gear guards are seam welded steel, hoist limit switches are of the exposed type in some cases, while in others they are of the totally enclosed geared type. We divide the traveling crane into three sections with respect to lubrication, and make one of the operators on each turn responsible to the motor inspector for the proper lubrication for that part assigned to him. With respect to fire hazards, we have provided each cab with fire extinguishers.

### Run-ways

When making repairs on crane requiring any interference on run-ways, we make the foremen in charge of repairs see to it that the regular crane operator remains in his cab, and is otherwise absolutely responsible for the safety of his crew and the other cranes on the same runway. We also use signs on the floor to indicate that work is being done overhead on a crane or otherwise. Very close contact is maintained also between repairmen and motor inspectors with respect to operation of electric circuits from a central substation. Our approach platforms are in some cases wooden ladders and steel platforms, and in the latter installations, steel ladders and steel platforms. We do not have any sanders on our cranes as we have not found it necsary to use sand on the rails as yet. We use rail stops or run-ways in some cases where it is absolutely necessary.

### Educational

We believe that the matter of safety with respect to traveling cranes can best be solved by closer cooperation between the cranemen and the crane follower, the motor inspector or electrical foremen and the department superintendent, and are working towards this end with rather gratifying results.

**Philip G. Fenlon:** Mr. Chairman and Gentlemen: I look upon your invitation to speak at this meeting both as an honor and privilege. This is the beginning of an association between your organization and the men in charge of safety for the steel industry that will bring about the results in which industry is now, and has been, so vitally interested—prevention of accidents to men engaged in crane operations and repairs. The co-operation of these two organizations, for the cause of safety, cannot but materially reduce crane hazards in the steel industry, and it is within reason to predict this interest will result in the elimination of such accidents.

The time limit necessarily placed on those assigned to subjects here today, does not permit of elaboration. Therefore, I will, as briefly as possible, endeavor to cover my assignment—that of ladders, stairways, runway-walks, crane platforms and repair platforms—within the time allotted me.

**Ladders**—Ladder approaches to crane runways should be eliminated and in their stead stairways erected. Ladders have been and are the source of many accidents; some serious and even fatal. Accessibility to runways for those having no real business thereon is certainly not desired and the placing of ladders on the plea of convenience should be discouraged. A properly constructed stairway leading onto platforms will eliminate this ladder hazard. The location of a stairway would depend, of course, on conditions and length of runways. The erection of one stairway should be sufficient where the runway is not more than five hundred to six hundred feet in length. Where they are of twelve hundred to fifteen hundred feet long, a stairway should be provided at both ends of runway platform.

**Runway Platforms**—Platforms should be extended along entire length of runways to enable cranemen and repairmen to get on and off regardless of crane location. Such construction should tend to better and safer inspection of cranes.

**Crane Platforms**—Crane platforms should be built flush with crane parts; not permitting of space through which materials such as bolts, nuts, or tools of any kind could fall through, possibly causing injury to men working or passing beneath cranes. This has been a source of many serious accidents. Platforms should be provided with toe boards on the outer edge as a protection against the same hazard of falling material.

**Railings**—All railings should be of angle construction for both strength and rigidity. The use of flats or pipe should not be considered.

The telescoping of walks over end carriages by trolleys is objectionable and to my mind most unsafe, for while instructions may be issued and thoroughly understood regarding care while repairing of cranes, it is, nevertheless, desirable that all possible hazards be eliminated. Telescoping of these platforms should be provided against by bumpers on trolley runway. Bumpers could be removed when necessary to run trolley out for repairs.

**Repair Platforms**—Repair platforms should be placed both on inner and outer side of runway for repairmen when changing wheels, brasses, etc., and for proper and safe inspection of inner parts of crane trucks and under parts of trolleys.

Steps similar to those known as "passenger type" should be extended from the crane platform to runway platforms over the runway rail. Steps, as a platform extension, preclude the possibility of men stepping onto track rail when getting on and off cranes. And while it may be contended that this is an unnecessary precaution if proper attention is given to the locking out of safety switches, yet when there are two or more cranes operated on same runway accidents have occurred from bumping of cranes while repairmen were ascending to the cranes, and fatalties resulted from men being knocked off runway.

I probably have exceeded the time allotted to me, Mr. Chairman, and my only excuse is the interest that I and all those present have in the matter which prompted this conference, that of co-operation for the safety of men against crane and runway accidents in industry.

**J. A. Northwood:** There was one phase in our morning program that I felt was missed. In talking to two or three of our safety men during luncheon time about it, they feel it is important as I do, that is, the psychology of the craneman to his duty. I do not know whether you fellows have that experience in your plants or not, but we have some of it. At a meeting of about 100 of our cranemen the other night in Johnstown the thing was brought up and discussed. One craneman asked me a question that I could not answer. The question was: "How are you going to get the men on the floor to stop cussing at the craneman?" There is a laugh in that and yet a whole lot to it. The craneman does something which perhaps from his view is right, but from the view of the hooker-on or man on the floor is not right, and the first thing the hooker-on looks up and lets out a big line calling him a boneheaded everything in the catalog. What happens? The fellow that is doing the hooking-on is sore, and the fellow on top is sore and they both begin to jam. Perhaps the hook or hitch has not been made properly. He is thinking of what the fellow has just called him. It is that kind of business that is causing some of our accidents, and I think that is worth giving a whole lot of attention to. A craneman must be even-tempered. You can call a man almost anything if you smile when you say it.

A subject like the above covers a great many questions, each of which in my opinion could be discussed for at least five minutes to the good of all present, but when five minutes is the allotted time for the entire theme it is hard to determine just where to begin.

**Guards**—The Department of Labor and Industry in their Crane Code determined that all gears on the crane should be covered, but did not state any definnite type of guard that should be used.

The experience in our plant has been that on cranes bought from outside firms there were all kinds and types of guards. Some were good and others were not so good. We had some experience with parts of these guards falling from the crane, in most cases not causing a lost time accident, but in one or two cases men have been injured from this cause. Upon investigation we found that the guards had been spot welded, which in my opinion is an unsafe way of making them. Other cases where guards were bolted we have found that the nuts have come loose and we have even had bolts rust out and thus cause the guard to come off. This causes trouble to both cranemen and crane inspectors, making it hard for them to remove the guards when necessary to make repairs.

The proper method of making guards as has been developed in our plant is that they should be seam welded throughout, and in designing them provision made to remove them quickly and easily. When a guard falls from the crane there is no question in my mind but that both the craneman and the crane inspector are responsible, as either one of them should have caught the condition before the final break came.

**Falling Crane Parts**—In my opinion falling crane parts are inexcusable, as very seldom the parts give way suddenly, but have been either shaken loose by excess vibration or have not been designed heavy enough to stand the strain that is expected of them. In the suggestion system conducted by our plant we had a shop man suggest that small baskets be hung under the motors of our cranes to catch the broken bolts that were continually falling from this part of the crane. This suggestion caused quite a little amusement with our Suggestion Committee and when forwarded to the superintendent of our Electrical Department for his approval he, of course, turned it down as "Not a prize winner," but assured us that if the bolts were breaking as often as this man stated they certainly were not designed to take care of the work that was expected of them, and that the size of them would be increased at once. The puzzle to me was why, when these bolts had broken once or twice and fallen to the ground below, the inspector or those in charge of our cranes had not investigated the cause of the trouble and corrected it. Had a man been seriously injured by a part of these bolts falling on his head and a lost time accident resulted, they would have very quickly fixed up the trouble.

In one of our Bethlehem plants a year or two ago a fatal accident occurred in one of their shops on Sunday, when there were only two men in the shop, the crane operator and a man on the floor. While moving a load a bearing cap came loose and in dropping, hit the floor man on the head, killing him instantly. It seems strange that with a large shop area that the only place that bearing cap would strike was on the head of the only man who happened to be under the crane at that time. Being a Presbyterian, I would say that this is just one more case of predestination and that this man's time to meet his Maker had arrived. The sad part of it, however, is

that it had to be classed as a lost time and fatal accident for industry.

As stated above, in regard to guards, in my opinion, Falling Crane Parts are certainly unnecessary and would not occur with proper systematic definite crane inspection.

**Failure of Rope**—When it comes to failure of rope we have a different matter. As a rule, ropes and cables show a failure in the strands before an extreme failure takes place. Of course, in the handling of hot metal they are watched very carefully. These cables and ropes are designed to carry different loads and if used properly last a long time. Yet, at times they fail and it is hard to determine just why.

The question of buying good cable and crane inspection are the only answers to safe practice with our crane cables.

In conclusion with this discussion, I wish to say that either from a safety standpoint or an efficiency standpoint, a lack of proper crane inspection is at the bottom of accidents that occur from the above causes.

Out of a total of 92 cases of fatal accidents, 48 were caused by direct carelessness of the method of operation.

Fourteen caused by the lifts not being securely tied, thereby allowing the load to fall, with the result of someone underneath being killed.

Fifteen by defective machinery.

Four by broken cables or chains.

Fifteen men working on cranes or crane runways.

**A. C. Cummins:** To one who has been interested in the activities of this Association it could hardly be possible to come to a gathering such as we see here this afternoon without expressing appreciation of the very gratifying co-operation given us by everyone concerned. When it is recalled that we started the Safety Section less than one year ago, it is inspiring to see so large a crowd of men interested in the work of improving the conditions in steel mills and other industries which affect so greatly the welfare of our industrial army.

**Guards**—I have come to the conclusion, after inspecting a great many guard designs, that the problem of guarding gears on cranes in steel mills has not been fully solved. If you discuss the matter of design with manufacturers of cranes, they will all tell you there are as many ideas as there are steel mill safety men and they would welcome some sort of standardization. At the time of our convention last year, we hoped to have each of the steel mills submit a sample of the type of guard which they felt most nearly filled the bill and that probably some benefit would be derived for all. Unfortunately, the time was too short, but I still think such an exhibit could do a real service to the steel industry. I hope we may have it in the not far distant future. Undoubtedly uniform guard designs would reduce the cost of guarding work, and to me, solving this problem is a field which the Association should enter.

What should the characteristics of the perfect guard be?

(a) It should be rugged and able to withstand vibration.

(b) The attachments should be so designed as to preclude any possibility of the guard falling from the crane.

(c) It should be designed to permit easy inspection of the gears which it encloses.

(d) If possible, after meeting the three above requirements, it should be oil tight.

The only objection that can be advanced to the present gear guard designs is that guarding gears makes the problem of inspecting the gears very much more difficult. Attempts have been made to solve the problem of inspection by enclosing one side with expanded metal or screen. Usually such openings become clogged with ore and grease and the inspection is no longer adequate. Before guards were put on our cranes it was possible for a man to examnie every gear and key in a few minutes. With tight guards, requiring removal for inspection, it requires several hours. The question comes to my mind whether we have not added more to the hazard of the men working beneath the crane by covering up the gears than we have reduced the chance of accident to the men whose duty requires them to work upon the crane.

There have been two accidents at our plant which indicate most clearly that we must solve the problem of easy access for inspection before we can say our cranes are 100% safe. One of these accidents was caused by a bolt becoming loose, dropping on the inside of the case, tearing a tooth out of a pinion which jammed in such a way as to tear the whole lower half of a gear case loose and caused it to drop to the ground, a possible serious accident. The principal thing that I can suggest for the improvement of guards on cranes would be a concerted effort on the part of some committee who would actively investigate this problem and attempt its solution. I hope that such an activity will appeal to the officers of this Association and I make it my recommendation to the Safety Section.

**Falling Parts**—As the safety movement progresses it becomes more and more apparent that the ultimate results cannot be obtained by applying mechanical safeguarding devices. Falling parts of cranes, particularly evidence this fact. It seems impossible to design guards to prevent parts of the crane proper from falling to the ground level, which, in turn, do not become loose themselves and cause trouble. It has been my observation that stringent discipline of cranemen in case hoists overtravel and the hooks run up kept the number of accidents from this source lower than the 100% application of limit switches. We have no limit switches which are entirely fool-proof, and we have tried them all. It, therefore, seems to me that more can be done by education than by further application of safety devices. This problem is one of maintenance as well as safety. If a department executive has successfully trained his men to be trouble anticipators instead of expert breakdown repairmen, production delays are greatly reduced and the matter of safety largely takes care of itself. It is, therefore, my conclusion that the most efficient way and in the long run, the cheapest way to eliminate the hazard of falling parts is by a campaign of education, and such a campaign, to be successful, must be carefully thought out, and logical in the steps of its development.

**Ropes**—In some plants it is customary to replace ropes when a single wire is found to be broken. At one of our meetings a rope engineer made the state-

ment that wire ropes were safe as long as the single wires broken were not nearer than three feet. I believe there are few plants that use rope until entire strands are broken. It is largely a matter of inspection and correct judgment when a rope should be changed, and therefore this problem is also one of securing a well trained organization. Ropes are expensive, and if changed too frequently add materially to the maintenance costs, and as competition in the manufacture of steel becomes more severe, it is necessary to do everything possible to get the maximum life out of our ropes, and yet avoid accidents.

In conclusion it would seem that the function of the Safety Committee of this Association is to start constructive work in solving the problem of standardizing accident preventive devices. It should not be difficult, as it only requires a little co-operation and a little willingness on the part of all concerned to give their ideas and to adjust their differences of opinion. Furthermore, the Association has secured the interest of the safety men who have been working on education in the problems affecting safety for a number of years. They are a very great asset and it would be unfortunate if the opportunity of securing their effort in developing an adequate program for educating men to maintain and handle cranes safely is not made use of.

**Geo. H. Schaeffer:** As regards the selection of switches, magnetic control and exposed current carrying parts, it appears to me that the electrical man does not have a very wide choice. I believe it is his first duty to pick the most efficient location as regards the efficiency of the operation being constructed. The question probably is subject to wide variation of opinion as to what we mean by most efficient location. I would consider the question of convenience to be convenience of location and ease of repairs. There are a number of dead places in a plant and it seems to me that this equipment is always placed in a dead place that is no good for anything else, even on a crane it is put in a place that is no use for anything else.

As regards the safety end. The proper equipment, in any case, if located properly, can be made to meet the standards of the safety committee. We want to get equipment that will have proper current carrying capacity and of proper size in every respect. Some of the fatalities are due to equipment not having proper current carrying capacity. In summarizing, the best location is that which is the most convenient in the efficiency of operation.

**Harry A. Lewis:** Twenty-five years ago we had limit switches working and felt as though it was a good thing. Mr. A. D. Wood succeeded in interesting Mr. Morgan of the Wellman Sever Morgan Company, who visited our plant to see it work. The operator was given orders to run it up, which he tried to do without success. After this failure we were unable to sell them. Limit switches of today are of the same type that we were working on at that time.

Mr. Greenwood conveys my ideas in operating a model steel works.

About thirty years ago I was connected with a steel plant which, to my knowledge, was the only one in this country to use 570 volts, D.C., with the negative side guarded due to it being part of the trolley system. From this early experience we learned a great deal about safety, as the operators and attendants were very badly burned due to this high voltage.

As electricity was introduced it displaced steam and this change eliminated the millwright and the men taking their places in the electrical department were inexperienced, as they had never completed a trade, therefore, they were very poorly equipped to carry on the work. It is a common belief that these men do not necessarily need be experienced, due to this attitude; low wages are paid and a very poor standardis maintained. To my mind, this class of men should be eliminated, as from experience we have found that a great number of unnecessary accidents and waste occur. If the managers of our mills were to make a study of the efficiency of this type of men, they would find the standard very low. Since competition is becoming very keen, a lot more thought should be given this matter, and the final results will be more safety with more profits.

**W. H. Burr:** I did not come to this meeting prepared to make a speech, nor do I expect to add much to the discussion of the papers which are being presented today.

My purpose in attending this meeting was to gather information regarding limit switches on cranes, and to suggest to the Association of Iron and Steel Electrical Engineers that a committee be appointed to draw up specifications covering limit switches, on the order of the crane specificationswhich the Association have already adopted. Manufacturers of limit switches would, in my opinion, be guided to a certain extent by the specifications in the building of limit switches for cranes. At the same time I believe it would have considerable bearing on the action taken by the state in approving limit switches for use in this state.

During the morning session considerable discussion took place as to who should issue orders as to loads handled by crane operators, and who should operate a crane when repairs are being made on night turn and no crane operator is available. No one at any time mentioned what penalty was meted out to an employe, not a crane operator, who operates cranes and cause serious damage to the mill equipment. I would like to hear how some of the men present handle this problem.

**E. F. Blank:** I think you realize, as I do, that most of the good that comes out of these meetings is the discussion which comes after the subject has been presented. On the inspection and lubrication of cranes, falling parts, failure of ropes, etc., there is no need to elaborate on the importance that lies in good inspection. I believe that we all agree that every crane should be thoroughly inspected at the beginning of every turn; that this inspection should be made by the operator and motor inspector, who should go over the crane to see that there are no broken or loose parts, that every active part is in A-1 shape. This should be checked up each week by more thorough, minute inspection by regular crane inspector. This inspection should be made by a man having bar and hammer and go over every part testing bearings, the tightness of bolts, caps, etc. This inspection also ought to cover the chains and cables. In one of our plants a chain and cable report is made out and a tonnage allowance, based on years

of experience, is made on the chains and cables of all heavy lifting cranes. These chains and cables are taken off at the end of this particular time regardless of condition. If parts are worn or frayed these sections are cut out and scraped and good portions are used on other work. The inspection of cables has been discussed somewhat as to when a cable should be taken off. I believe it is a good deal up to the inspector's judgment as to how many broken strands and how much wear should be allowed. In regards to lubrication, the important thing is that cranes should be lubricated regularly. Good lubrication is very essential to the safe operation of the crane. The safety engineer is interested in this from a safe operation standpoint, but as a general proposition, the inspection and lubrication is up to the electrical department and in my opinion can't be too thorough.

**C. E. Bedell:** There is nothing in particular I have to say on the subject before us, but would rather refer back to the topic of education of cranemen. Someone has said we ought to educate our cranemen. Well and good, but let us see how far this applies. If we mean in operation of the crane, yes! but if we mean in the crane mechanism, no! His responsibility lies in the safe operation of his crane, but he should not be required to know the electrical and mechanical mechanism of his crane. As soon as we begin to try and educate him along these lines he immediately thinks he knows all about it and begins to make adjustments. For example, we may all be expert automobile drivers, but it is is doubtful whether we are all qualified to adjust all the insides of one. We no doubt think we are capable, just as the crane man thinks he is, but doesn't the automobile suffer the worse for our meddling?

A crane man is hired for a specific purpose and he should be thoroughly qualified for that position, but we should not have him making repairs and adjustments except as a helper with the inspector or crane repairman.

As to responsibility of crane man in lifting. He should be held chiefly responsible for making safe lifts. He should not hoist unless he is satisfied that the hitch is safe.

As to gear guards. Much has been said about covering the gears and again about the difficulty in removing the same guards for inspection. Is not the time coming when practically all gears will run enclosed and in oil! The cranes then will not run unless covered and inspection will not be required so frequently. Let us work to this end, an ideal crane, no gear guards to come loose, no bushings to renew, no oiling to be done, just push the lever.

**C. E. Sankey:** One of the speakers said he trained his operators by giving them a card showing they were authorized operators of the crane. That was tried in our plant and was not successful, because they used it as a labor organization and did not train the other men properly. We tried another system. Now that you electrical engineers can think of the man who is in the mill and from whom you must gather your men to do this work that you are talking about, remember this, that the crane is the most dangerous piece of machinery in the mill. There are more accidents connected with it in the state of Pennsylvania than any other way. In hiring cranemen, the man who hires from the floor gang is right. You must take those men after six months' experience in the mill, treat him with intelligence and give him a chance. Have him fill out an application and go before the doctor; then go to the superintendent. The superintendent of each department is held responsible for the department he is in. Don't take a chance with a man's life. Oftentimes you can do that, but if you do, you can't have a decrease in accidents and injuries. So hold the superintendent responsible for the crane and the cranemen, and that superintendent hold the electric superintendent responsible for the electric part and mechanical superintendent for the mechanical part. The electric men work only on the cranes, but don't work on the floor.

**Chains and Cables:** Mr. James said the Carnegie Steel Co. had been using no chains for 20 years, only cables. Many plants are equipped with chains. We recommend cables, but where we don't have the space use chains. You should have inspection by chain inspector and cable inspector. Above all, hold the craneman responsible. If a hookup man is practically a new man that goes into a mill, he will hook up a load without any judgment whatever, and the craneman should refuse to lift that load. The craneman will tell the floorman why he don't lift.

**Falling Material:** To those who erect cranes. You can't have different views as to different sizes of bolts; they should be standardized. There should be grooves where you put the wheel in. Some millwrights thought they should be sprockets. We had to go over cranes and make sure they would not come out.

When there is carelessness we first reprimand, then give two days, then 10 days and then discharge. A good many start cranemen too young. Twenty-one is about right; he understands men's lives are in danger. We tell him the safety department is only an agent of the company. They get rules and regulations. They read them over but forget them. We give an extra half-hour's pay for keeping the crane clean. If you have a clean crane you have a safe crane.

**John S. Kenney:** It seems to me that we are going to have pretty good cranemen if they do everything expected of them that has been mentioned here. One thing we do have in our plant; no matter how small an accident we treat it as a breakdown. The craneman gets the inspector right on the job. The craneman explains to the inspector, from there the inspector goes to the floorman or hook-up, forms his opinion; then goes to the foreman; takes this spill-up with the foreman and thrash it out. Then it is brought to me and we get together on it and we determine to the best of our ability the cause, and if we find it is the craneman's fault, we take it up with that man and act accordingly. If we find it is caused by the hook-up or somebody else on the floor that has authority, then take it up with his foreman and if we don't get action, take it to higher authority.

**Question of Control:** Levers all operate in the same direction, and controls are placed in all cranes in the same location, bridge, trolley and hoist. On every crane the controllers are placed the same.

On platforms, I would say that the crane cab should not run back over the crane platform. In other words, there might be somebody standing on the platform waiting for this crane, and would be caught if crane were run over platform. I think the

bumpers should be so arranged that the crane cab or anything else should not extend back over the crane platform.

We are as fast as possible putting stairways in to replace ladders.

On ropes, I have heard some mention about breaking of strands. I presume individual wires in strands are meant, not a complete strand. I wouldn't think it would be safe to let a complete strand go and still operate. I would like to hear what strands are used in different size cables. We were using ⅝ cable, 6 strands, 37 wires, on 15-ton crane, but changed to 6x25. We change our cables as soon as we find any frayed parts, whatever, or if not frayed before they are too much worn.

For lubrication, we put oil on cables to grease them. We have to be careful not to get oil and grease on the floor or finished product.

As to limit switches, sometimes they go on through, no matter what you put on. Our rules are to try limit switches at the beginnig of each turn and the middle of turn.

**M. M. MacDonald:** I would like to know what the opinion or practice is on authorizing a crane operator to operate a crane. In other words, he is an authorized representative of whom or what department? Namely, who or what department shall authorize a craneman to go in a crane cab? What is good practice? I have tried different things. I find this: Fundamentally, the business of all of us is to produce steel, no difference whether we are directors or electrical engineers, we are there to produce steel. I want to know from this organization, or anybody in the organization, what is the best practice on that—whether you should issue an order that nobody but authorized cranemen should go in a crane cab to operate crane.

**John James:** No one but authorized cranemen should operate the crane.

**C. E. Sankey:** Our practice is this: When a man goes to the superintendent and says I want to be a craneman he gets a check number and sends it up to the safety department; we turn him over to the doctor or hospital department. He is examined as to eyesight, etc., and if efficient and looks wise enough, and has fulfilled the requirements so far, we return that man and say he shall be on crane one week under experienced craneman. At his leisure time he can go up and run that crane. After seven days they send him back to the safety department to see what he has learned; then we put him through a schooling on what he does and tell him what he has to do before he goes back to the superintendent. Safety first before the superintendent gets him. Have him sign a slip, tear it off and take it to his superintendent, that he has been authorized to run a crane in that department. To run a crane over in another bay he has to go through the safety department. The safety department controls the cranemen.

**John James:** The foreman could authorize the craneman to do the job. He knows whether the medical department has passed him or not; he knows the condition of the man; he knows what cranes the man can operate; he knows if the man is familiar with the ground conditions or not No one should direct or authorize the operation of that crane except the electrical foreman of that department.

**M. M. MacDonald:** What I want, and what you want, is a majority opinion of this organization. That Is What We Want. You can't get it here because there isn't time; but, if this organization sends you a letter and asks your opinion, you can think this over and write back and express your opinion. In that way we have a majority opinion. In our plant, we hire the crane operators, and we don't hire a crane operator from outside unless we have to. It has been touched on that when you hire an outside man he says, I am a crackerjack good man and can run anything on wheels. The question is not how or where he will run, But How Long He Will Run. He is a "floater," and we know what a floater is when we see one. When I hire a man who is a floater, I say to him: You may be a crackerjack good man, you ran a crane here and there, and you may be a good craneman, but, You Are Only a Good Craneman When You Are Good in Every Respect. In other words, if you come here and run a week and quit, you will cost this company more than your services are worth in that period of time. We try to pick our men by internal promotion, depending on ability to step up. We give seniority preference, providing everything else is equal. The electrical departments puts the man on that crane, and determines his ability to handle that crane from a mechanical and electrical standpoint. We consult the superintendent; how is that man on that crane; is he satisfactory to you? If not, no matter how satisfactory he is to us, he goes off that job, because the superintendent of that department is the man we are working for and is the man who has the final say as to whether this man is capable or not.

I would like to ask Mr. Cummins how they determine a cable's life?

**A. C. Cummins:** We don't determine the life of cables. We try to have it inspected. But, nevertheless, if we find any individual wires broken on hot metal crane the crane immediately goes off, and the cable is removed after six months' service, regardless of condition. I am speaking of hot metal crane.

**M. M. MacDonald:** Is that good practice?

**A. C. Cummins:** It is probably not, if you haven't any other place to use cables. We take them off and use them on car dumper or use them on some crane where loads are extremely light and the chances of falling are extremely remote In other words, it is not scrapped when removed from hot metal crane, providing no individual wires or strands are broken.

**M. M. MacDonald:** When we take rope off we use it for slings or for pulling slag pockets, etc.

**A. C. Cummins:** They can be used for slings.

**M. M. MacDonald:** Shouldn't we go further and get the fatigue point? I say that the cable is good, but our metallurgist says there is a fatigue point in any steel, and regardless of what you can see with your eyes, it should be taken off after a certain period of time, depending upon the service. In other words, to illustrate my point more clearly, a cable used on a hot metal crane to all appearances is in first-class shape, but the metallurgist says it should come off. He don't tell me when to take it off. Perhaps it might be good practice, if, after we have had six months' service out of that cable, we were to take it off and send it to the rope manufacturer and

ask him to put it under test. That is, after so many tons handled, make a test on it to see if the rope was drawn or strained. Assuming that the conditions remain the same on the above-mentioned rope job, a test such as spoken of might enable us to definitely determine when a cable should be changed.

**A. C. Cummins:** That might be true. Sometimes we have had cable failures which, under carefully made test, were all right. Cutting off and sending it to the manufacturer would give you an indication if weakened, but the life of a cable is determined by the sheaves over which it runs. In other words, the amount of bending it has been subjected to. It should be taken off for one or two reasons; first, individual wires are bent back and forth, so that some of them are fractured; and there is a certain amount of abrasion, those strands are partly worn through. As far as I can see, all conditions being equal, if cables are inspected frequently, no indication of abrasion and no broken individual strands, that is a good indication that it is still in good shape.

**M. M. MacDonald:** Do you have a steel expert who tells you which shall come off?

**J. S. O'Donovan:** A gentleman handed me a little question in regard to use of chains. We know there are times we have to use chains where we cannot use ropes. He asked me to find out what they thought about carbon of the steel and how thickness ought to be determined. He called my attention to the fact that in case of an accident that happened several years ago, where a chain was apparently sound and that when it broke it broke through a burnt weld.

In regard to crane operators, up to a certain time at our plant, as electrical engineer, I have charge of all operators There was a time we thought best to change that method and glad ever since it has been changed. We have possibly 50 cranes and eleven different men hire those cranemen. Can you tell me how they can get a standard? We have little trouble at present. The only trouble we have is having charge of all repairs. As far as inspection of cranes is concerned, our companies will not and could not economically give us enough men to inspect cranes at the beginning of every turn. We have one group of 11 cranes and three men to inspect those cranes.

In regard to cables, just as soon as we find our cables are beginning to wear or if strand breaks, we change the cable. We have two cranes that will wear out a set of cables in two weeks. We use 6x19, as we find they wear longer than 6x37 cables before the strands become flat and break.

Another thing spoken about, exposed current carrying parts on cranes. I do not think we ever had a man hurt on current carrying part of crane. It is only the experienced man that comes in contact with that part.

We have practically eliminated all ladders and use stairs made of angles and some of pipe. At one time we got up a little malleable casting to be bolted on pipes. Stairways were made with 60° angle. I believe State Department don't like 60°, but there are many places we could not put stairways in unless we used 60°. As to fire hazard on cranes, I believe that has not been touched upon. The biggest thing in fire hazard as far as crane is concerned, is to get crane away from fire hazard when it occurs underneath it.

**Walter Greenwood:** You have spoken about exposed current carrying parts. What would you suggest to take care of bus bar in the way of insulation?

**J. S. O'Donovan:** You cannot insulate a bus bar.

**John James:** In regard to cables, I would not advise you to use a cable when it begins to look like a razor-back hog. They ought to be taken out when they begin to get flattened or frayed.

There is a question up before the Carnegie Steel Company regarding cotter pins in bolts. Somebody has advised that all bolts should be equipped with cotter pins. If you want to know something about gear cases, ask R. J. Harry, electrical engineer of Homestead Steel Works how to make a gear case.

In regard to limit switches: I dare say that equipping the cranes in the Homestead Steel Works has saved money. There are limit switches installed there, I dare say on 90 per cent of the cranes. I know the per cent that are not is small. Limit switches on those cranes have saved lives and property and delays. I advise you to equip cranes with limit switches wherever possible; it will save you money and accidents.

In addition would like to say that many delays, accidents and costly breakdowns have been caused by well-meaning floor hands, mill foreman and even department heads insisting upon old as well as new crane operators breaking crane rules, which have been made for the protection of each and every department which requires crane service, and we have found that where our crane operator's rules have been obeyed, breakdowns, delays, accidents and many hazards have been eliminated. But regret to say that there is still some misunderstanding in regard to signals from floor hands which should, at this time, be given serious consideration and which often is the cause of many minor and serious accidents which can be eliminated only by more stringent ground rules, enforcement of the same and a hearty co-operation with the craneman upon whose efficiency depends the successful operation of the greatest steel industries of the day.

**H. M. Lee:** There are some things that, as inspectors, we feel we should bring to your attention. As regards lubrication; that is the life of the crane. Unfortunately, a number of manufacturers make the provision for lubrication away down inside the runway where you can't reach it. It is a simple matter to bring pipes up and put oil cups on top or force grease into the bearings through some type of compression cup or grease gun. The thing is to get some kind of lubrication from the bridge of the crane so that the operator will not have to get inside and miss half your bearings. Then you wonder why they cut out.

Another matter is breaking of cables. I remember one instance where we changed so we would not have reverse bends and increased the life of the cables 300 per cent. Another bad thing is too small diameter drums and sheaves. Either reverse bends or too small diameter drums or sheaves will cause a cable to fail in short order.

We have had occasion, within the last week, to inspect a factory in which the operators were crawling up into the cab over bare feed wires.

Another thing we have found is the use of operators too young. State law provides a minimum age

limit of 18 years. We have had another accident where two operators came together with monorail hoists. They were too young. They were running at high speed and were plugging motors to make stops. Unfortunately, the controller locked in "on" position; the two cranes came together.

One other item. In handling cranes, there was, in times past, a disposition to take anybody to make a crane operator. I believe, if we bring a crane operator into the skilled labor class, we shall get somewhere. We will attract a class of men that will be worth while, and shall not need to pick up anybody that comes along for this purpose.

**Frank W. Cramer:** It has been an agreeable surprise for most of the operators present here today to learn that the cranemen are getting some consideration. At our Cambria plant, we have over four hundred (400) men employed to operate cranes, and feel that they all do their best to give service and also maintain the safety regulations. In the mills where the labor turnover is low, they acquire a knowledge of the work to be done each day, and become very efficient. On new construction jobs, it is a different problem, and with strange ground men, and an endless variety of lifts, sometimes friction will develop. The cranemen have a lot to put up with, and it is only fair to insist on the crane director, or whatever the ground man is called, giving him the best of co-operation.

On the subject of workmen on runways, there are a few points that should be given consideration. The first is that the workmen be given a platform to work on, and thereby eliminate the hazard of falling. Then, if the crane must be kept in service while the workmen are on the runway, we place a man in the cab with the operator, whose duty it is to keep his eyes on the workmen, and warn the operator when he gets too close. In addition to this, a cap can be placed on the rails as a further warning to the operator should he approach too closely to the workmen, and further than this, rail clamps are mounted back of the cap. There have been some objections to the danger of the clamp upsetting the crane, in case they are hit too hard, but with both a man and a cap to warn the operator of an approach, the chance for hitting the clamps is very remote, and if he did hit the clamp, it would take excessive speed to cause an overturning of the crane. A cap will not stop a crane; the operator must do that, and we feel that the clamp is an added security.

Mr. Cummins touched on the subject of gear guards for cranes, which is a live issue in the state of Pennsylvania at this time. The existing code is retroactive and says all gears must be guarded. The new cranes are all designed with this condition in view, and can easily be provided with guards, but with old cranes, it is often a difficult matter. We have ben trying to live up to the law, and have gone to great expense in equipping the old type cranes with guards, but after we have done this, have we really made conditions safer? We will have several hundred nuts, bolts, washers, plates, etc., up in the air that were not there before, and by simple mathematics, it stands to reason, the more parts in the air, the more chances for some to fall down. Then, when guards are put on, they must be so designed that they can be taken off for inspection and repairs. This makes inspection more difficult, hence less thorough than it was with open gears. The chances are some of the bolts and nuts will work loose at times, and the inspector has the added duty of keeping these tight. So long as the present law is in force, we must comply with it, but from a safety standpoint, on the old equipment, do we really gain any advantage from the guards?

One of the speakers said that all cranes should be equipped with ladders, but this is impossible on some types of cranes. This point was given careful consideration when the A. I.& S. E. E. crane code was adopted. It was found that stairs could be made so steep that they were more dangerous than a ladder, and it was recommended that the angle of the stairs be limited to 55° with the horizontal. Our thought was that a safe ladder was more desirable than an unsafe stairway.

**A. C. Cummins:** In regard to the matter of cursing cranemen, it seems to me the way to solve that problem is through department safety committees. One of the greatest opportunities for service by safety committees is correcting such lack of interdepartment co-operation as such practices evidence. I am certain from experiences in our plant, thanks to our very efficient safety department, that trouble from such sources will soon be eliminated. I believe the electrical engineer feels he is very much indebted to the safety engineer for developing a medium through which such abuses can be corrected, and due to this co-operation and assistance discord between operating departments is rapidly being eliminated.

Someone mentioned sanders. This brings to mind something I observed on a recent trip to Chicago. One plant in that district has runways absolutely free of grease and oil. The means used to accomplish this ideal condition is the elimination of filling track-wheel bearings with oil. Instead, the bearings are packed with an oil or grease treated waste, and it is never necessary to add oil during the life of the packing. That oil is automatically eliminated from the runways. It may be of interest to those who have not heard of this material to learn that it is necessary to remove the waste from the bearings about once a month, loosen it up and it may then be replaced in the bearing. I was told that six months' service was being secured before the oil treated waste had to be discarded, and if this proves to be the average service to be expected in steel mill duty, the material offers great possibilities for reducing lubricating costs, as well as improving the conditions under which men must work on runways and cranes from a standpoint of safety. We are now experimenting with this material at the plant with which I am concerned. It is too soon to announce whether it has proved entirely satisfactory or not.

Very few accidents involving hot metal are due to actual failure of cables. Most failures are caused by failure of hooks, in the handling of the crane, or by improperly engaging the hooks on trunions. I cannot recall of any case of hot metal accident in the Pittsburgh district in recent years in Steel Corporation plants, in which ropes were primarily at fault. When you consider the amount of hot metal handled by the mills in Pittsburgh, it indicates that the practice of changing cables every six months at least avoids accidents, though it may be expensive. However, in most large steel plants the cable re-

moved from cranes handling molten metal can be used on less hazardous work until its full life is utilized and hence the cost is not a serious item.

**H. G. Hamilton:** You have talked over nearly everything from an operating standpoint about cussing and discussing cranemen; I would like to know about what you would like from an engineering standpoint. I was sent down here because it is my duty largely to design the crane runways and the cranes for the company I am connected with. I was with that company for seven or eight years and was with another company and saw some crane designs, and with all due respect to some of the gentlemen who represent that company, I think even they could be improved on. The approach of that cab did not suit me very well. I would like you to tell me what constitutes a safe crane runway. I was sent by the chief engineer to investigate crane runway where there were three parallel buildings. The trouble was that the crane runways were pinched together, causing wheels to wear and climb off the rails. They were replacing crane wheels every two months. I was sent out to brace it so it would not pinch. When I looked at the crane runways could see no sign of failure from overhead structure; then looked at the foundation. There was a brick retaining wall and column foundations were incorporated in the retaining wall. When it heated it expanded and columns were 8″ narrower than normal in one wall and in the other 6″ or 7″. I recommended cutting the wall and taking column foundations off the wall. The column base had failed. It looked like foundations were moving. Anchor bolts were gone. Their track wabbled six inches. I wouldn't have gone in the crane cab for twice his salary. The whole thing could have been avoided if designed with A-frame bases.

I would like to have some safety men or operating men express their opinion on what constitutes a good safe crane runway.

**Walter Greenwood:** In reply to the question concerning what constitutes a safe crane runway, we cannot understand why anyone would assume the element of danger connected with them can be removed any more than it can be removed from a railroad track. It is there and your safety, if you approach it, depends on your own watchfulness. Some of the speakers, in discussing the hazards connected with crane runways, seemingly have advocated the use of rail clamps to protect men from moving cranes on runways within certain zones. We wonder how many electrical superintendents advocate the method and how many are aware of the hazard connected with such a practice. Track clamps may be efficient for stopping a crane, but the other likely results should be considered. These things have happened: Cranes have skewed and become permanently distorted; they have been thrown off the runways; sudden stopping has thrown the operator off his feet, and in one instance, at least, has thrown him out of the cage. The hazard can be controlled by a number of better methods without adding this more serious hazard.

Judging from the discussions we have listened to, not all electrical engineers nor all safety engineers have read all or nearly all the literature concerning safe operation and making safe installation of electrical equipment they had access to, or should have had access to. We are in doubt as to whether any of either class have carefully studied the provisions of the National Electrical Safety Code, or much of the literature issued by the National Safety Council. The A. I. & S. E. E. has, during its existence, discussed every matter brought up here, and these discussions have been fully recorded in their annual publications of proceedings. Also, everything here discussed has been considered by the National Safety Council in Safe Practice Pamphlets. Our A. I. & S. E. E. some years ago adopted a code of rules for safe operation of overhead electric traveling cranes, also the National Safety Council adopted a similar code. The first rule in each code forbids anyone not qualified from operating a crane. This rule should answer the questions about what to do in emergencies for economy's sake or for any purpose.

In regard to safe loads for chains, for some purposes they are practically indispensible, as where they are used for attaching loads to lifting tackles. Where the loads they handle are of any considerable size it cannot be said they are dependable, even though their size gives them the proper factor of safety, and although they may not have been subject to stresses that might leave them defective, they always are liable to breakage from links being "cocked" when stress is applied. They may be so used that unnatural stress is placed on individual links to break or seriously impair them when their capacity is abundant for straight pulls. The best practice in regard to chains is to educate users to realize chains are never safe, and they then will be likely to guard themselves. For some purposes chains, under rated capacity, are less liable to fail than are chains of sufficient capacity. The reason is, the shorter links are less liable to stresses that will bend them, as in the case of wrapping them around loads having projecting angles. Convenience sometimes demands that chains must be used which are not as heavy as they should be.

The discusisons today have demonstrated to me that beneficial results will follow closer intercourse between electrical employes and safety engineers in the iron and steel and their affiliated industries, and my hope is, they will continue the movement here started.

**S. L. Henderson:** I think that Mr. Greenwood has taken us all to task when he remarked that he did not think all of us were as serious as we should be on the subject of safety. I should say he meant that we had not gained sufficient knowledge or were sold on some of the things that were discussed today. I have been here all day and I believe I am voicing the sentiments of everyone present when I say we have derived much benefit from this meeting and would suggest that such meetings be held more frequently.

We have had several cranes equipped with sanders for the past two years and have found that they work out very nicely, not only from a safety, but from a crane operating standpoint as well.

There has been considerable time lost in sanding the rails by the old method, due to the fact that the operator would either have to scramble along the runway with a bucket of sand, which he preferred not doing, or have a man ride the end carriage throwing sand on the rails. We found this to be bad practice, as it was seldom that the sand hit the rail

and stayed there, in fact, it seemed that most of it went into the bearings.

It is also very bad practice from the safety viewpoint, for while the man is walking the runway with a pail of sand, a slip of any kind can easily prove fatal, and with a man riding the end carriage a moment of forgetfulness on the part of the man or the operator will no doubt cause a very serious accident.

On cranes not equipped with sanders, the operators leave the sanding of the rails go until it is absolutely necessary, which is bad, as it causes undue strain on both the cranes and the runways, and naturally makes the operating rather difficult.

Since the sander is operated from the cab, the operator feels more responsible for his crane, therefore the rails are kept in better condition.

No serious trouble is experienced when cranes are new, but after a period of time runways and cranes loosen up a certain degree and result in poor alignment. It is my opinion that this is caused to a great extent by the excess strain imposed upon them by poor traction.

I think we will all agree that new cranes as well as old should be equipped with sanders, and that if the runway rails are sanded whenever they become slippery, it will serve to keep the cranes and runways rigid for a much greater length of time.

Ore bridges and ore bridge trolleys are exposed to all kinds of weather conditions, making the use of sand necessary. Thus, from the safety and also the operating standpoint, sanders can be used to advantage.

**A. C. Gibson:** Because self-preservation is the first law of man, we will take up first those rules and regulations applying to the safeguarding of the runway workmen.

First, he must be fit for the job; part of the Boy Scout requirement would fit here very well—"physically fit and mentally awake." Tools should be taken up and lowered with a hand line, and tools, too, should be in the best of condition, as cramped conditions, usually found on runways, are handicap enough without attempting to use improper tools.

Second, the operators of cranes on the runway should be notified that workmen are at work on the runway and they should understand what is to be done and any part they are to take in the work. If the work to be done is at the extreme end of runway, and it is possible to cut out crane service to that part of building, the proper thing to do would be to put up a temporary rail bumper, plainly marked with a flag or light. The crane operator should be notified of this condition, and also warned to approach stop cautiously, as the repairmen might find it necessary to work momentarily in the unblocked section, and caution is necessary also, because of the temporary character of the stop.

If the repair job is big enough to warrant it, the current should be cut off that section concerned; this, of course, is easier to do when end of runway is involved.

When other than end sections of runway is to be repaired, rail stops should be used to block off section involved, if time will warrant. If this cannot be done, one of the repair gang should be put in operator's cab, whose sole duty will be to look after his fellow-repairman's safety, warning the operator when nearing the repair job. It would be best to have this man able to handle the crane also. W. W. Hall, of Illinois Steel Company, Chicago, has stated that it would be a good plan to have crane operators serve a term with the repair gang, principally to get their point of view as repairmen and to instill proper regard for hazards of their occupation.

Track torpedoes have been advocated to be placed within a reasonable distance of the section being repaired. On the explosion of the torpedo the operator must not proceed without instruction from repair foreman or man on guard.

So much for repairmen on runways where cranes are to be kept in service during the repairs.

Where the crane on the runway can be taken out of service pending repairs to runway, safety switches should be locked open until job is completed. In either case, warning signs should be placed under runways warning men on floor of workmen above, and better still, the space should be roped off to keep men from under work overhead.

Last, but not least, a careful inspection should be made on completing job to see that no parts be left lying around on runways to fall off, meaning, particularly, bolts, nuts, wrenches and bars.

According to standards of Association of Iron and Steel Electrical Engineers and Safe Practices Pamphlet of National Safety Council, there should be a platform or walk the entire length of the runway. This walk should be not less than 20 inches wide. Space may not permit these foot walks in existing buildings, but they should be considered in plannig new buildings. This walk should be reached by one or more stairs or fixed ladders, preferably stairs.

Rail stops should be made up of steel plates and should be fastened to the girder rather than to the rail. They should be of generous proportions and curved to fit the wheel.

Regarding sanders, I shall take the liberty of quoting from a paper by W. S. Hall, of Illinois Steel Company, on maintenance of cranes.

"Adequate facilities for proper sanding of the rails should be insisted upon. These sanders can either be hand-operated or electrically operated. In either case, the control of the sanding equipment should be in the operator's cab. In my opinion, electric sanders are more readily installed and, if given ordinary care, are more positive in their operation. The practice of a man going onto the crane runway to sand the rails periodically is one of the most hazardous practices in connection with crane operation, particularly so if more than one crane operates on the runway. In many cases adequate protection for the man from falling is entirely lacking, making the job particularly dangerous from this standpoint alone on account of accumulated grease and dirt making it almost impossible to obtain a sure footing while doing this work. Periodical sanding is very unsatisfactory at the best. If the sanding equipment is mounted upon the crane and under the positive control of the operator, the sand can be applied when needed and not after the crane has failed to stop or start, as is the case with periodic sanding of the entire runway. There are many cases where no sanding is required. However, when new cranes are ordered for a new installation the sanding equipment should be included, and if later on it proves itself

unnecessary, the equipment, if electrically operated, can be removed and installed on some other crane where it will no doubt prove of value. If the sander is mechanically operated, the interchange between cranes of two different designs may be not quite as readily made."

**John A. Oartel: Rules**—There are two things very evident to the American people today; one is that we are afflicted with a lot of rules and they are trying to impose more on us every day. That is very evident, and yet another thing that is just as evident to all thinking men, is that civilized society must have rules if it shall continue to exist.

We have a lot of ideals set up today in referrence to cranes. We hope the day will come when all these ideals will be worked out with reference to construction of cranes in all details; that these ideals will be worked out with reference to crane operators. In other words, when all cranes will have operators as good as Mr. Baker, who has operated this crane so successfully today, and yet when that point is reached, we will still need rules. Because we have two men trying to work together, the craneman in his cab and the man on the ground, and as long as two men work together we will need some rules of conduct for them or they will run amuck.

The Carnegie Steel Company has printed some rules for cranemen and some rules for groundmen We have tried to look down into the plant where steel is produced and realize they are trying to produce steel. We don't want to handicap them with rules that nobody observes, yet we believe certain rules are necessary for safe operation of cranes.

### CARNEGIE STEEL COMPANY

#### Signals and Rules for Ground Man Controlling Crane Operations

(These signals are six in number, as follows: Hoist, Lower, Stop, Rack, Travel and Emergency Stop.)

(1) Use these signals to control the operations of Crane—DO NOT SHOUT AT THE CRANEMAN.

(2) Signals to craneman shall be given by one man only on each job. (Cranemen are instructed to take signals from one man only).

(3) Before giving any signals be sure you are where the craneman can see you.

(4) Remove all twists from chains before making hitch.

(5) When lifting loads be sure the hitch is safe before giving signal to move.

(6) Keep hands off hooks, cables and chains while lift is being made.

(7) Keep from under loads carried by cranes.

(8) Do not endanger your own life and the life of the operator by overloading the crane.

### CARNEGIE STEEL COMPANY.

#### Safety Rules for Crane Operators

The following rules must be strictly obeyed:

(1) None but regularly authorized persons are allowed to operate crane.

(2) Before starting, be sure nobody is working on or around crane.

(3) Do not handle any loads which do not look safe to you; report to foreman before making such lift.

(4) Do not operate crane when it is not in a safe condition; report to repairman any repairs which you cannot handle.

(5) Avoid carrying loads over men; never carry molten metal or magnets over men.

(6) Do not allow anyone to ride on load, hook or magnet.

(7) Do not leave cab without first putting all levers in the "off position"; open main switch and lock same before oiling or making any repairs.

(8) Do not push another crane unless you are sure nobody is working on it.

(9) Use stairways or ladders to go on crane.

(10) Test limit switches and brakes at the beginning of each turn.

(11) Inspect crane thoroughly each turn, oil properly and keep clean.

(12) Do not eat, smoke or read while running crane.

(13) Do not keep inflammable material (such as oil, waste, clothing, etc.), in cab; remove all loose parts from crane.

(14) Move only on signal from the proper person; be sure hook is directly over load to be lifted, and be sure everything is clear

(15) Do not hoist too high nor lower too low; you are liable to injure someone.

(16) Do not move cars under any condition, except where tracks are equipped with snatch blocks so you can pull staight up with hook.

**S. L. Henderson:** I would like to ask if anyone present at sometime has had a crane operator become temporarily disabled in such a way that it was impossible for him to shut off the controllers while operating some particular travel. There may be cases where an operator will temporarily become paralyzed or faint from natural causes, making it impossible to perform his duties and in such cases a serious accident may result.

On ore bridges we frequently install wind brakes on the bridge moving to prevent them from being blown along the runway by high velocity winds. In order to move the bridge, it is necessary for the operator to stand on a plate in the operator's cab and, through a movement of an inch or so of this plate in the downward direction, it closes a control circuit for a magnetic contactor, which, in turn, releases the brakes and supplies the bridge moving motors with power. Therefore, it would seem that since we cannot use a dead man's controller on cranes due to the two or more operations moving at the same time, that an arrangement of this sort might work out to advantage on cranes. Inasmuch as it requires most of his weight on the plate to function properly, the crane operator, as well as the ore bridge operator, would, in falling, reduce the weight on the plate sufficiently to operate the safety features, thus stopping the motors.

**Walter Greenwood:** If he will visit our McDonald mill he would see an installation where you stop a crane within a certain limit as is practical. To stop a crane dead is an impractical proposition when you consider the weight of a crane. But there is such a device constructed and you can see one in operation at McDonald mill if you come there. It is very easily applied and perfect in its work.

**C. L. Baker:** I am sure if you men have enjoyed this meeting as much as I have, you would vote it a

success—not due to your "Crane Operator," I assure you, but to the wonderful interest and attention and remarks that have been made by every man that has spoken today. There has been a sincerity, a marked sincerity, in every man who has spoken on any subject.

We are only trying, in our feeble way, as a Safety Division of this great Association of Iron and Steel Electrical Engineers, to help prevent accidents in your steel works. When I say your steel works, I believe nine-tenths of the men who are here today, are employed in the Iron and Steel Industry; in other words, that is the waywe are making our living. If we have done anything or if there has been anything said that will help us in the future to lower accidents in the Iron and Steel Industry, not only in Pennsylvania, but in the entire United States, we will surely be well paid for the day spent in this meeting.

I want to thank you, gentlemen, for the courtesies you have shown the Chairman today. Outside of the fixed program, after a subject had been presented by a speaker, it has not been necessary for me to call upon you gentlemen for remarks or discussion as you responded voluntarily and the remarks made by the different members, who took part in these discussions, conclusively proved their interest in all subjects presented in this meeting. This has been very gratifying, as we are expecting to go on with the work of the Safety Division and the success we may attain will be entirely what we care to make it.

This is the first sectional meeting that has been held under the supervision of the Safety Division of this Association, and if this meeting has shown any indication at all of what you members think of electrical safety in the steel plants of this country, I assure you that we have taken a long step forward today.

It is this Association's desire, I am informed by the Officers and Directors, to be of greater benefit year by year to the Iron and Steel Companies of this country.

I thank you, gentlemen, for your very fine attention today to the speakers and I trust that our visitors from other departments of the Association will consider holding a safety meeting in their division some time during the present year.

As Chairman of this Division, I assure you that I will be glad to co-operate with any Division when they decide to put on a safety meeting in their particular district. The question of Safe Operation of Electrical Traveling Cranes is not the only electrical safety matter that we have to think about, and with the full co-operation of the Iron and Steel Industries of the different states with the five divisions of this Association, I am sure, will urge us on to greater activity in safety work as it affects the Iron and Steel Industries to which the work of this Association is dedicated.

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# *Lighting Costs*

By D. W. BLAKESLEE*

IN addition to illumination design, there are a number of other factors in a lighting system which should receive serious consideration. An important factor is dirt. Dust and smoke collects very rapidly on the lamps and reflectors in applications such as foundries, furnace shops, gas producers, coke ovens, forge shops, machine shops, locomotive houses, rolling mill buildings and the like. Each application should receive individual consideration.

To illustrate, the following is presented in a large steel works: The average lamp is taken as 200 watts and on a basis of burning 16 hours a day and washing the lamps and reflectors every four weeks. With energy at 1 cent per kw.-hr., its cost per lamp between cleaning periods is $0.86. Tests have shown that at the end of the four weks there is a loss (due to dirt) of 60 per cent of available illumination; cost of energy lost during the period is $0.32. The cost of washing the lamp and reflector is about $0.05. Total loss, $0.37 per lamp.

The lighting equipment may be cleaned by dry wiping at times between washings, the cost of wiping being about $0.03. If the wiping were done every alternate second week the cost of energy lost would be about $0.20. The cost of washing and wiping $0.08. Total, $0.28 per lamp. If the wiping were done every week, the cost of the energy lost would be about $0.12, and that of the cleaning $0.14; total, $0.26.

The increasing loss of illumination due to the accumulation of dirt between cleanings may be visualized by Fig. 1, which shows that the shorter the interval between cleanings, the greater is the amount of illumination obtained. Of course, the cleaning could be done so often that it would cost

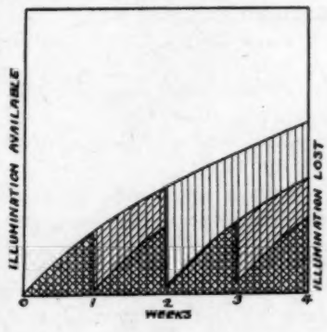


FIG. 1.

more than was saved in cost of energy for lost illumination. To determine the right period for cleaning, the cost of the cleaning and the cost of energy should be considered together. This is best done by drawing graphs of the two costs against time between cleaning periods. From Fig. 2 it may

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be seen that when the curves cross it is the most economical time to clean the luminaries. Curves of this sort should be drawn up for each set of local conditions if they are to be the most useful. The curves shown are with the lamps in RLM standard dome reflectors; with other lighting fixtures the cost of cleaning may be higher and the cost of the energy lost more. With larger lamps, or with the lamps in

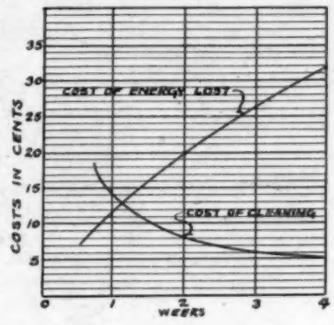


FIG. 2.

operation more hours per day, the cost of the energy absorbed by the dirt will be greater. In cleaner applications the loss of energy in the dirt will be less.

In our example, with 1150 RLM reflectors containing 200-watt lamps, the losses due to dirt with the cleaning done monthly, every two weeks, or every week, are $425.50, $322.00 or $299.00, respectively. The saving in energy lost by cleaning weekly instead of monthly is enough to pay the wages of another man to clean lamps. Of course, the main object of cleaning is not to prevent loss in dirt, but it is to permit the lighting system to provide the il-

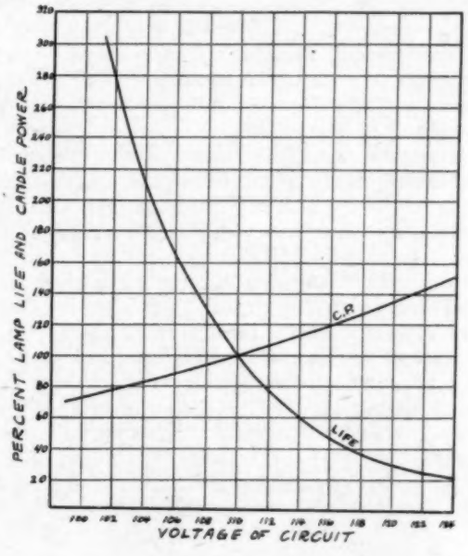


FIG. 3.

lumination for which it was designed. Depending upon the work done under the illumination, the return from the average increase in foot-candles of illumination measured by the increase in output of (say) the machine shop, may run as high as ten per cent.

The voltage at the lamps should receive very careful consideration. This voltage should be the rated voltage of the lamps; if it is more or less, there will be a loss in a reduction of the life of the lamps or in the illumination, respectively. From Fig. 3 it may be seen that but a few volts above or below the rating of the lamp means a considerable loss.

With the 110-volt lamp on a 115-volt branch, it has only 50 per cent normal life. With the 110-volt lamp on a 105-volt circuit the candle-power of the lamp is but 85 per cent of normal. Returning to our example, let us say that of the 1150 lamps, 300 are across 115 volts and 400 are across 105 volts. This means purchasing about 200 more lamps per month, at a cost of about $1.00 each, due to the higher voltage, and a loss of about 15 per cent of the illumination of the 400 lamps which is equal to that of 60 lamps not burning, representing a loss something like $750.00 per year.

Disconsidering the reduction in the output of the work due to lower illumination, the factor of dirt due to unscientific cleaning and the factor due to

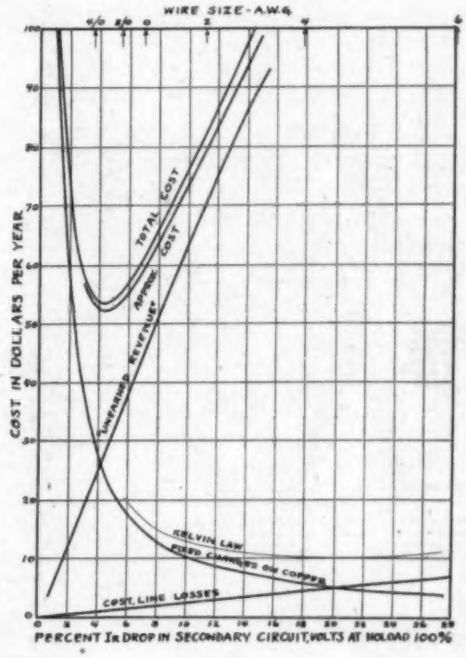


FIG. 4.

improper voltage across part of the lamps both as treated above in our example, results in a direct loss of $4,650.00 per year.

The method for determining the proper cleaning period has been given above; the only way to procure correct voltage at the lamps is by design of lighting primaries and secondaries to give the necessary voltage drops in the various parts of the circuits. The usual method for determining the size of conductor for a circuit is by the Kelvin law, which is the resultant of the cost of the line losses and the fixed charges on the copper; from Fig. 4 it may be seen that the lowest value by the Kelvin law is for the $I_r$ drop, where the component curves cross.

In lighting secondaries the conductors are operated at such low densities that not the $I^2_r$ loss, but the voltage drop is the limiting factor. The Kelvin law is based entirely upon the cost of the loss in input without regard for the economic effect of reduced voltage at the lamps. This additional loss,

which has been termed "unearned revenue," represents the net return from the additional energy that would be used at the higher lamp voltage if the secondary line drop were reduced to zero. The total cost per year may be taken as the sum of the cost of the line losses, the fixed charges on copper, and the "unearned revenue." In the industrial plant when the energy is not purchased, the "unearned revenue" is not **kilowatt-hours unsold,** but LOSS DUE TO LOW VOLTAGE. What this loss amounts to depends upon local conditions and must be calculated for each application. It may mean more in a self-dependent industrial works than it would to a central generating station. Curves in Fig. 4 indicate "Unearned Revenue" and Total Cost. From the size of the wire shown at the top of the figure it may be seen that it may pay to use a secondary conductor four times as large as that indicated by Kelvin law.

For the large secondary conductor, the line loss is relatively small and it may therefore be disconsidered. Subtracting it from the Total Cost, there is produced a curve Approximate Total Cost, the lowest point of which comes so close to the lowest point of the Total Cost curve as to indicate the same size of wire. Therefore, the size of conductor to be

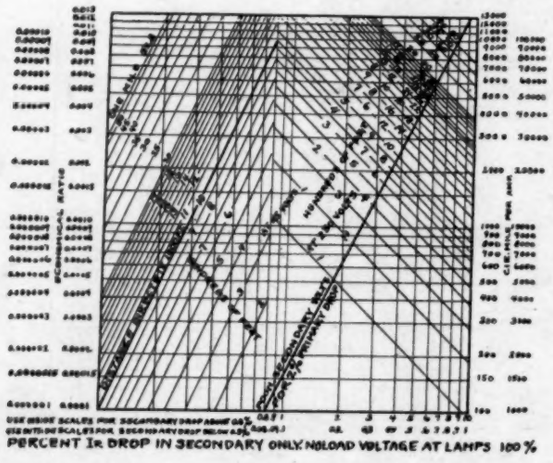


FIG. 5.

used may be determined by the point where cross the curves of "unearned revenue" and fixed charge on copper.

So that many laborious calculations need not be made, Fig. 5 may be used to determine the economical wire size and voltage drop for lighting secondaries. To use this chart, it is first necessary to calculate the Economic Ratio for 1000 ft.; which is equal to

$(3.7 \times N \times N' \times g \times C)$ divided by $(E^2 \times V \times F)$, where

N = Number of conductors with respect to relative size.

For 3-wire, 1-phase, neutral ½ size, N = 2.5

For 3-wire, 1-phase, neutral 2 sizes A.W.G. smaller, N = 2.63.

N′ = Number of conductors carrying full current only N′ = 2 for both 2 and 3-wire systems.

C = Cost of conductor in dollars per pound of actual copper. As an approximation for TBWP, multiply charging our price by 1.2 for sizes 1/0 to 4/0 and by 1.3 for No. 2 to No. 6.

g = Annual fixed charge rate on insulated wire; including interest, depreciation and taxes.

V = Net return from lighting per kilowatt-hour.

F = Loss factor, derived from typical daily load curve,

$$F = \frac{\text{Sum of the squares of the hourly ordinates}}{24 \times (\text{Ordinate of annual peak load})^2}$$

E = Volts at lamps at no load. Per cent line drop is based upon no load volts = 100 per cent, and should not be confused with "regulation" based upon per cent rise above full load voltage.

I = Current at peak load.

P = Equivalent number of 100-ft. pole sections from transformer to load.

Example A: Compute economical size of wire and voltage drop for a two-wire, single-phase secondary circuit supplying a tungsten lamp load 700 ft. from the transformer. Maximum amperes = 30. Copper $0.16 per pound, with fixed charges at 15 per cent; net return per kilowatt-hour $0.07; loss factor of 10 per cent. Primary drop assumed 2 per cent.

$$\text{Economical ratio for 1000 ft.} = \frac{3.7 \times N \times N' \times g \times C}{E^2 \times V \times F} = \frac{3.7 \times 2 \times 2 \times .15\ (0.16 \times 1.25}{115^2 \times 0.07 \times 0.10} = 0.0048.$$

From 0.0048 on the left scale of the economical wire size diagram project horizontally to distance directrix, then vertically to line for 700 ft., then horizontally to economical secondary voltage curve. Read economical per cent secondary drop, 3.8 per cent, on bottom scale. Project vertically to 115-volt curve for 700 ft. and read 3400 cir. mils per ampere on right scale. Total circular mils = 3400 x 30 = 102,000 cir. mils. Nearest standard wire is size 1/0.

If served by three-wire, 115-230 volts, single-phase secondaries:

$$\text{Economical Ratio} = \frac{3.7 \times 2.53 \times 2 \times 0.15 \times 0.20}{230^2 \times 0.07 \times 0.10} = 0.00158$$

The economical secondary drop is 2.2 per cent and the circular mils per ampere = 2900. Total circular mils = 2900 x 15 = 43,500 Nearest wires size No. 4, with No. 6 neutral.

For distance or voltage other than for which the chart is drawn calculate the Economic Ratio, which is $(0.037 \times N \times N' \times g \times C \times P^2)$ divided by $(E^2 \times V \times F)$; where P is the length in hundred feet to a decimal fraction.

Example B: Compute economical wire size for house service drops. Length 75 ft., 2-wire, 115 volt, loss factor 5 per cent, maximum amperes 6, other values same as in Example A. Since no line is drawn for P = 0.75, calculate the economical ratio as follows:

$$\text{Economical Ratio} = \frac{0.037 \times N \times N' \times g \times C \times P^2}{E^2 \times V \times F} = \frac{0.037 \times 2 \times 2 \times 0.15 \times 0.20 \times 0.75^2}{115^2 \times 0.07 \times 0.05} = 0.000054$$

Using the outside scales on the chart project from economical ratio 0.000054 on the left scale directly to economical voltage curve. Economical secondary drop equals 0.58 per cent. Economical mils per ampere is computed by

$$\frac{2120 \times P}{E \times \text{Econ. per cent sec. drop} \div 100} = \frac{2120 \times 0.75}{115 \times 0.0058} = 2380$$

Total circular mils = 2380 x 6 = 14,280. The nearest size A.W.G. is No. 9, but the nearest size commonly used is No. 8.

# Application of High Duty Worm Gears in Steel Plants*

By A. L. HENTHORN†

IN recent years considerable development work has been done in connection with worm gearing, one of the oldest methods of speed reduction used by engineers. The modern worm gear is, however, a very distinct refinement over the old familiar type of worm gearing which everyone knows was inefficient and not very reliable.

The development of the modern worm gear originated in Europe and was introduced into America in the automotive field. This form of gearing was a marked advance over the older forms of worm gearing, the design being radically different and the materials used in its construction were a decided improvement over anything previously attempted.

The De Laval worm reduction gear is the result of a very exhaustive study of the latest practice both here and abroad and embodies the most improved elements of design, together with a thorough knowledge of the forces developed in a worm reduction gear. The workmanship of this worm gear is of the very highest order, every part being machined to limit gauges, and the materials used have been carefully chosen so that each part will function with the greatest degree of reliability. Before elaborating on the various applications of this worm gear to the Steel Industry, it might be well to review the details of its design.

The worm is the straight type integral with the shaft, and is made from a low carbon nickel alloy steel forging, heat treated and hardened. The object being to produce a hard surface on the worm threads to resist wear, and a strong, tough core to withstand heavy loads. A high or medium carbon steel would be entirely unsuited for the purpose, because if heat treated for a sufficiently hard wearing surface, the shaft would be too brittle and if the temperature is drawn to prevent brittleness, the wearing surfaces would not be hard enough, resulting in a higher coefficient of friction, greater heating, lower efficiency and rapid wearing. The heat treatment is performed in electric furnaces, in which the temperature is held constant by means of thermo-controlled switches. A check on the furnace temperature throughout the heat is obtained by recording pyrometers and time switches are used to insure the proper duration of the heat. In following this method of heat treatment, the very best results are obtained and a uniform product is assured.

A low carbon steel worm subjected to the above heat treatment, although producing ideal conditions, unfortunately distorts the worm so that it cannot be used in this condition. In order to correct the distortion, the worm is set up in a machine as nearly accurate as is possible with reference to the worm threads, recentered, and the cylindrical parts ground, after which the threads are ground to an accurate lead on special precision machines designed and built expressly for this purpose. Not only must the worm threads be most carefully ground to the correct lead, but they must also be spaced with extreme accuracy to insure the proper distribution of the load on the threads. In the thread-grinding operation the thread surfaces must be ground to a smooth, glass-like finish, since no polishing operation can be permitted, as this distorts the accuracy produced in the grinding machines. Great care should be taken to obtain accuracy in the worm, since it is the controlling member of a worm gear set as the gear, being made of softer material, conforms to the worm.

The worm in the small and medium-size frames is mounted on ball bearings, one of which is of the duplex type, making the thrust in either direction, as well as the radial load; and the other is of the single annular type, taking the radial load only. The thrust bearing is locked on the worm shaft and securely clamped in the case, while the single radial bearing has a radial fit with an axial clearance, so as to permit expansion of the worm shaft without cramping the bearings. In the larger frames the worm is carried on babbit journal bearings and the worm thrust load is supported by an independent double-acting thrust bearing.

The worm gear consists of a chill cast phosphor bronze rim shrunk on a cast iron center, and is machined and generated on its own bearings so as to produce a true running pitch line. The gear is mounted on a shouldered shaft ground all over. The slow speed shaft is mounted in plain bearings cast of high lead bearing bronze, giving a low coefficient of friction. Bearings are split and can be removed without displacing wheel shaft or coupling, and are so designed to take care of overhung loads such as chains, gears, crank arms, eccentrics, etc., within reason.

The housing is of the heavy mill type design throughout and is made of cast iron split horizontally and machined to limit gauges to insure perfect fit of all working parts and interchangeability of parts. Heavy ribs tie the journal bearing housings to the feet, preventing weaving of the side walls. The lower part of the gear forms a large oil reservoir with baffle plates cast on the bottom for the collection of sediment. Oil cocks are provided to indicate the oil level, which must be maintained. The feet on the housing are so designed as to permit the circulation of air under the oil well.

Apart from correct design and accurate workmanship, lubrication is one of the most important factors for the successful operation of a worm gear. Under most operating conditions a splash system will give satisfactory results. There are, however, certain condition where the splash system cannot be relied upon and a positive pressure oiling system should be used. The positive oiling

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*Presented at Philadelphia Section, January, 1926.

system applied to our worm gears works as follows: The oil is drawn through a large strainer, located at some distance above the bottom of the oil reservoir, by a pump which delivers it through passages in the casing to spray nozzles placed on both sides of the worm and also to all bearings.

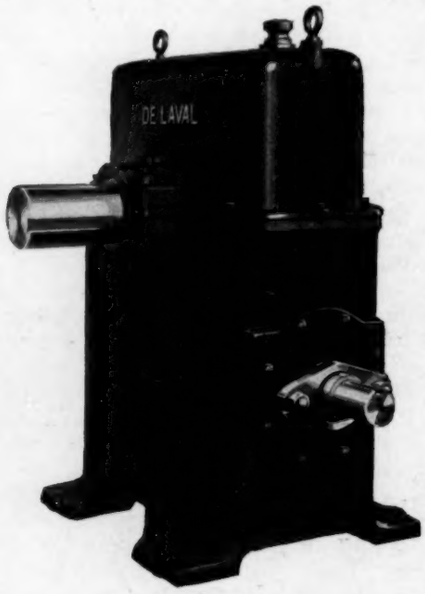


FIG. 1.

A relief valve prevents excessive pressure, and the pump housing is arranged so that the oil may be passed through a cooler when operating conditions require the use of one. The oil passages are so arranged that they can be easily cleaned, and the

FIG. 2.

spray nozzles taken out without disturbing piping. The supplying of oil by pumping rather than by splashing eliminates excessive heating, due to the churning of the oil when operating at high speeds and the foaming of the oil due to churning.

The worm reduction gears are built in a number of different sizes and several different styles, such as the worm mounted under the gear (Fig. 1), the worm mounted over the gear (Fig. 2), the wheel mounted on a vertical shaft, also double reduction frames (Fig. 3), all of which have found a place in the steel industry. Ratios as high as 8000 to 1 can be obtained in the double reduction gears and a number of these are used on cooling tables and conveyors.

In the design of the tooth form, a pressure angle of 30° has been used, thus entirely avoiding undercutting. This form of tooth is exceptionally strong, as failure would have to take place by crushing rather than bending, since the pressure line normal to the face at the pitch line falls within the base of the tooth. In ordinary spur

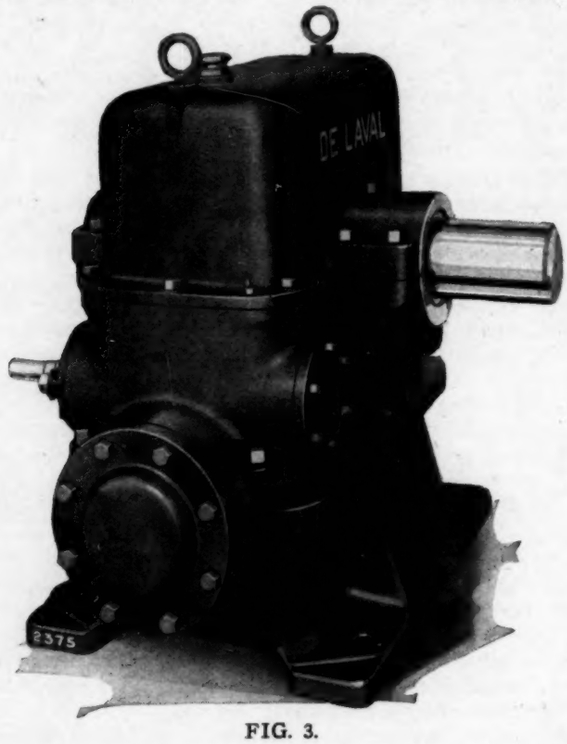


FIG. 3.

gears, the projection of this line falls without the base of the tooth, and such teeth often break off at the base.

The efficiency of Worm Reduction Gears gradually rises while the worm is seating itself in the wheel, after which the efficiency remains constant throughout the life of the gear. With spur gears, on the other hand, the efficiency is highest at the start and gradually decreases because the teeth do not wear in such a way as to maintain continuous contact. With such gears the rotation is accomplished by a series of hammer blows, which increases in force until the teeth strip, but with Worm Reduction Gears there is a smooth, easy transmission of torque, due to the manner in which the teeth of the worm enter into contact with the worm wheel and to the fact that several teeth are always in contact. This adds greatly to the life of driving and driven machinery, and frequently, also, improves the quality of the work produced.

The right angle arrangement of the shafts of the Worm Reduction Gear often permits of a better

arrangement of machinery than do other speed reducers.

Fig. 4 shows a large size worm gear driven by a 425 HP turbine at 3300 RPM. In this drive the reduction is about 7 and the service is continuous, 24 hours per day.

Fig. 5 shows a worm gear driven by a turbine operating a generator of 75 KW capacity. An interesting point in connection with this illustration

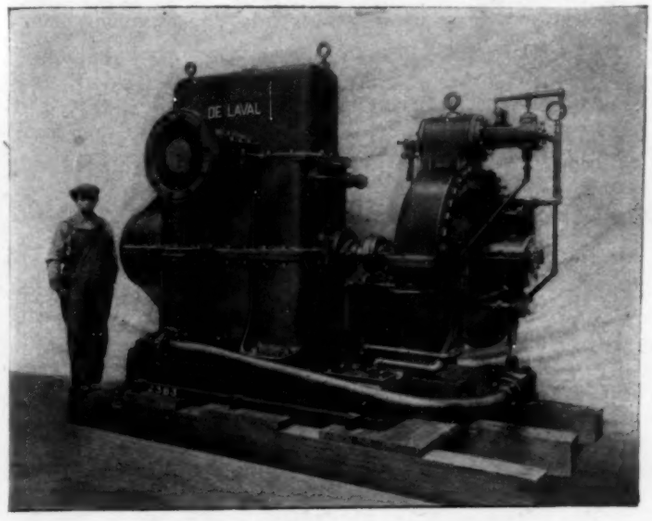


FIG. 4.

is the speed of the worm, which is, we believe, far in excess of anything heretofore attempted, the speed being 6100 RPM.

Fig. 6 shows an application of worm gears operating gas valves on a soaking pit. The reduction in the worm gear is 60 to 1 and an interesting feature of the illustration is the crank mounted on the slow speed shaft.

Some other installations to which worm gears have and can be applied are enumerated as follows:

McKee six way valve
Soaking pit mechanisms
Mill tables
Turnovers in bar mills
Strip steel windups
Swaging machines
Magnetic Separators
Coal crushers
Sintering machines
Pickling tanks
Winches
Feed roll drives
Wire weaving machines
Open hearth furnace tilting mechanism
Car dumps
Kick-off drives
Heat treating and annealing furnaces
Wire enameling machines
Cooling table—ratios as high as 2000
Slag screens
Small mills
Hoists
Cranes
Soaking pit crane closing mechanisms
Car hauls
Door lifts (open hearth furnaces)
Draw benches
Gas producers
Line shafts
Machine tools
Blowers
Generator sets
Grizzlies
Coke pushers
Decarburizing machines
Axle straightening machines
Piler tables
Billet pushers
Ingot feed
Fencing machines
Bending roll strippers
Trough drives
Pusher racking and buggy drives
Transfer tables
McKee magnetic rollers

### Scarfing Machines

The application of Worm Gears to conveyors of all kinds and bucket elevators is ideal, as direct connection can be made to the slow speed shaft, eliminating all forms of open gearing, chains, etc. Space is conserved and the unit as a whole is extremely compact and affords adequate protection to workmen.

The application to cooling and mill tables has the same advantages, and in addition, on account of the smooth-running qualities of the Worm Gear, noise and vibration is eliminated. By eliminating vibration, motors are protected to a considerable degree and motor maintenance reduced.

Probably one of the most interesting applications of the worm gear in the Steel Mill is the application to cranes. The worm gear is peculiarly adapted to crane service, as all the necessary reduction can be made in one step on the hoist mechanism, the drum being mounted on a through shaft to which is keyed the worm wheel, making a three-bearing design, the worm drive housing being an integral part of the trolley side frame. The same holds true with the cross travel drive. The complete reduction can be made to the cross travel through shaft or part of the reduction made and followed up by one spur gear reduction to the through shaft.

The advantages of a modern high duty worm gear over spur gearing on a crane trolley are very apparent. Noise is entirely eliminated, and as the flow of torque is extremely smooth, long life of both motors and gearing should result.

Apart from the application of Worm Gears to Mill Machinery, many forms of auxiliary apparatus in power plants may be driven either by motors or turbines, such as stokers, fans, pumps, generators, coal pulverizers, etc.

It is very important that before the installation of a gear is made, that the full details covering

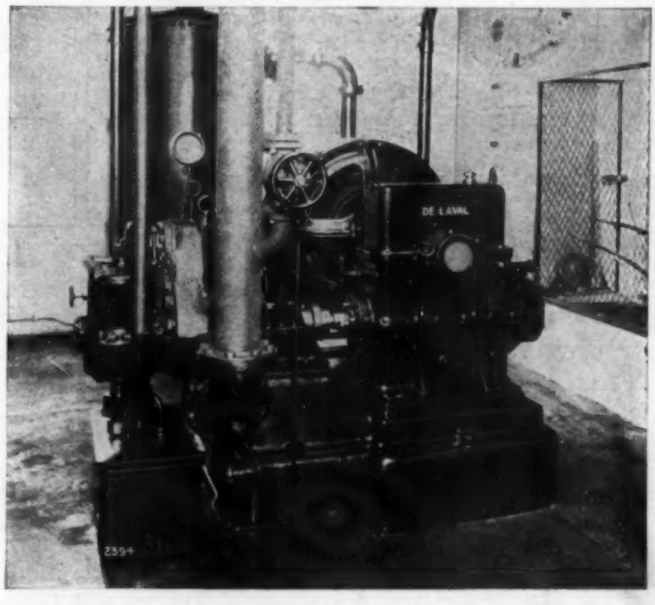


FIG. 5.

the operating characteristics be reviewed, so that the many factors involved in a speed reduction will be taken care of adequately.

Worm Reduction Gears have the following outstanding advantages:

COMPACTNESS—Compared with belts, chains, ropes or trains of open gearing, considerably less space is occupied.

SMOOTH FLOW OF TORQUE—In worm gearing three or more teeth are at all times in contact. The wedge-like action of the worm threads coming into contact results in an even flow of torque. This eliminates vibration, and not only greatly improves the quality of the work produced, but also materially prolongs the life of the connected machinery, especially

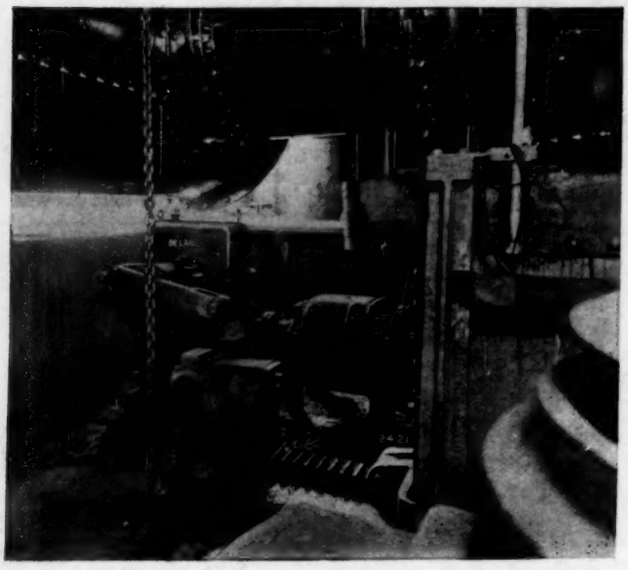

FIG. 6.

gearing and bearings. Uniform flow of torque frequently permits of greater output, since, with Worm Reduction Gears, machinery speeds may be increased to an extent not possible with other types of reductions, which set up vibrations, due to the intermittent spur gear tooth contact or the tendency of chains to whip and climb on the sprocket teeth.

SILENCE—Owing to the fact that there are always several teeth in contact, pulsations and the customary gear noise are eliminated. The absence of noise in a plant is conducive to efficiency of employees.

POSITIVE TRANSMISSION—There is direct connection from motor to driven machine through flexible couplings, eliminating the power losses resulting from belt friction and slippage. As no subsequent shifting of the motor is required, slide rails are unnecessary.

FLOOR SPACE SAVED—Power is delivered from a worm reduction gear at right angles with the motor position, thus keeping the motor out of the plane of the machine and permitting of closer arrangement of machinery without sacrifice of aisle space.

HIGH EFFICIENCY—The efficiency is high, often reaching 97% for certain ratios, and is maintained throughout the life of the gear.

STANDARDIZATION OF MOTOR SPEEDS—The wide range of reductions obtainable in worm gearing permits of the standardization of motor speeds, reducing the investment in spare motors. The large reductions in speed possible frequently permit the selection of high speed motors, resulting in less cost, better efficiency and improved power factor.

SIMPLICITY—Fewer moving parts are employed than in any other form of reducer, eliminating many bearings and gears. The mechanical parts are strong in construction and easily accessible for inspection.

SAFETY—All moving parts likely to cause injury to workmen are enclosed, rendering safety guards unnecessary and preventing explosions which might be caused by free sparks.

LONG LIFE—All moving parts are completely enclosed in a dust-proof housing and run in a bath of oil, thus giving ideal conditions for long life.

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# *Frequency Converters for Interchange of Power Between Steel Mills and Central Stations**

By FRED J. SCHWARZ†

A BLAST furnace will theoretically supply enough gas to generate all the power required to roll and finish all the steel made from the iron produced by the furnace. However, the irregularity with which this gas is produced does not permit of its most efficient utilization, so that in times of maximum steel production there may not be sufficient gas to produce the power required for rolling and finishing and, conversely during periods of reduced production, there may be an excess of gas which cannot be stored or utilized, and hence would be lost.

The present tendency toward conservation has created a closer association between the Steel Works and the Central Station Companies, having as its object a more efficient utilization of all available sources of power.

The ideal case would be where the steel mill would use all the available gas for the generation of power, using this power for finishing steel, either supplementing it with power purchased from the

*Presented at Cleveland, March, 1926.

†Industrial Engineering Department, General Electric Company.

Central Station or delivering the excess power to the Central Station system. The Central Station would supply all excess demand and accept all excess power available from the gas.

A practical case would be for the Central Station to supply power to the steel mill during working days and for the steel mill to furnish power to the Central Station system on Sundays and holidays. In this way, it would not be necessary for the steel mill to burn coal during the periods of gas deficiency and maintain the equipment necessary for the conversion of coal to electric power. On the other hand, the Central Station could conserve its coal during the periods when the gas produced by the blast furnaces exceeded the requirements of the steel mill.

Many of the steel mills which generate their own power generate at 25 cycles, while most modern Central Stations generate at 50 or 60 cycles. Therefore, to interchange power between these two systems, requires some means of converting from one frequency to the other, and at the same time cause no disturbance in the operating conditions as they exist.

The load on 25-cycle Steel Mill systems fluctuates considerably, and the voltage and frequency regulation is frequently very poor, due to extreme governor regulation of the prime movers. It is not usually feasible to adjust the governors to hold frequency with variable load on the system, due to the system being frequently made up of a large number of generating units of various capacities and types. Instead of attempting to hold frequency, the governors are set as near alike as possible, so that the load will divide properly, and the frequency of the system is allowed to vary with the load in accordance with the governor regulation.

On the other hand, the 60-Cycle Central Station frequency is practically constant, due to the comparatively large size of the system and the diversity of the load, but which, at times, may vary sufficiently to cause difficulty with any rigid tie-in.

The problem, therefore, presents itself of connecting together by frequency converters two systems, one of which has a relatively constant load, voltage and frequency, and the other has a voltage and frequency which vary considerably, whose load fluctuation and whose frequency cannot be easily controlled for synchronizing with other synchronous machines.

The synchronous-synchronous type of frequency converter, consisting of a synchronous motor driving a synchronous generator, is the most common and familiar type. A set of this type forms a rigid tie between the two systems and, although it may be desirable from the standpoint of simplicity, of construction and operation, price, efficiency and ability to correct power factor, it has many disadvantages, especially when used on two systems having the characteristics mentioned above.

In the first place, for the successful operation of a synchronous-synchronous set, the ratio of the two system frequencies must remain constant. Any variation in this ratio will overload the set and may cause it to pull out of step. These sets, of course, may be designed for high pull-out torque, which would permit maintaining operation of the set during momentary fluctuations in the frequency ratio, provided, however, that this fluctuation in frequency does not overload the set beyond the pull-out torque point, and provided that the duration of this frequency change is very short.

Secondly, this type of set does not permit of synchronizing or the control of load transfer, except by the adjustment of the speeds of the prime movers of the two systems, which, to say the least, is inconvenient.

The synchronous-synchronous set, therefore, does not adapt itself readily to the tying together of a

FIG. 1.

constant frequency Central Station system and a variable frequency steel mill system. To meet the conditions of varying frequencies, load control and synchronizing, there has recently been developed a type of frequency converter consisting of an induction motor with speed regulating control direct connected to a synchronous generator.

The speed regulating control is a modification of the well-known Scherbius type which has been successfully used on approximately seventy equipments driving main rolls and totaling approximately 108,000 HP, also on five 6,000 KW frequency converters of the type described in this paper.

The speed regulating or Scherbius control frequency converter consists of a normally designed synchronous generator with direct connected exciter mounted on the same base with and direct connected to a 3-phase induction motor of the wound rotor type and of normal construction. This set is also provided with an ohmic drop exciter, whose function will be explained later. An auxiliary set is also required, this set consisting of a squirrel cage induction motor and a polyphase commutator type alternating current motor.

Fig. 1 and Fig. 2 show a frequency converter of this type and Fig. 3 shows the regulating set used

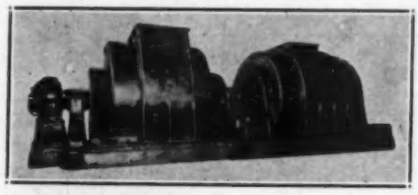

FIG. 2.

with this converter. This set has a capacity of 6000 KW and operates at a speed of 720 RPM. The regulating set is rated 500 Kv-a.

Before describing the operation of the Scherbius controlled induction synchronous type of set, perhaps it would be well to give a brief resume of the principles of the speed regulating or Scherbius control, the theory of which is explained in an article entitled "Speed and Power Factor Control of Large Induction Motors by Neutralized Polyphase Alter-

nating Current Commutator Machines," written by J. I. Hull.

It is well known that if a voltage drop or a counter voltage at slip frequency is applied to the slip rings of a wound rotor induction motor, the speed of the rotor will adjust itself so that the voltage generated will be just sufficient to send through the secondary circuit the current necessary to develop the required torque.

The Scherbius regulating set supplies just such a voltage at slip frequency. This voltage is made adjustable so that the speed can be changed by varying the voltage.

The regulating set usually consists of a squirrel cage or wound rotor induction motor direct connected to a neutralized polyphase A. C. commutator motor. The armature of the regulating motor is similar to that of a direct current machine; the stator

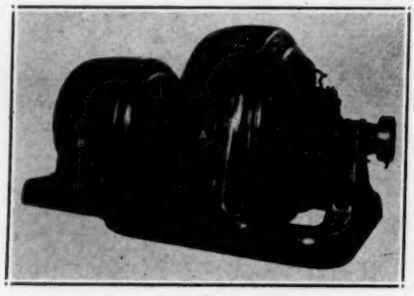

FIG. 3.

has three distinct windings—a shunt or main exciting field winding, an interpole winding and a compensating winding. The main exciting field winding receives its excitation from two sources—first, from the slip rings of the main motor and, secondly, from an ohmic drop exciter which is described below. The interpole winding is used to obtain good commutation. The compensating winding neutralizes the armature reaction and assists commutation.

The induction motor of the set may be operated above synchronism as an induction generator for delivering back to the line, except for the losses in the regulating set, the power delivered to the regulating set by the rotor of the induction motor, or as an induction motor operating below synchronism taking power from the line to drive the regulating set when the main induction motor operates above synchronism and requires power input to its rotor.

The ohmic drop exciter, which may be considered the heart of the equipment, is a very simple device, capable of always supplying a constant voltage at slip frequency. It consists of an armature similar to that of a rotary converter, provided with both commutator and slip rings, and wound with the same number of poles as the main motor. The armature is mounted on the shaft of the main motor so that its speed is always the same as that of the main motor. The stator of the exciter has neither slots nor windings. Since it is usually designed to handle three-phase current, its commutator is usually supplied with a multiple of three sets of brushes. This exciter has the property of giving a constant voltage with a varying frequency, the frequency always being exactly the same as that of the secondary circuit of the main motor.

Power is supplied to this exciter through the slip rings from the main lines through suitable transformers. If the rotor is at rest, the voltage applied to the slip rings creates a magnetic field which revolves at synchronous speed with respect to the rotor, the same as in an ordinary induction motor. If the armature of the main motor be rotated at synchronous speed and if the phase rotation of the ohmic drop exciter be such that the direction of rotation of its magnetic field is opposite to the mechanical rotation, the magnetic field would no longer rotate but would stand still in space. The armature conductors revolving at synchronous speed would thus cut this stationary flux and a voltage would be generated which would deliver direct current from the brushes on the commutator just as in a direct current generator. At one-half synchronous speed, the magnetic field would be rotating at half speed and the armature at half speed, with the result that the armature conductors would still cut the flux at the same rate, and the voltage generated would, therefore, be the same as at synchronous speed and at standstill. The frequency, instead of being zero as at synchronous speed, would be one-half of the normal frequency applied to the slip rings of the ohmic drop exciter, or exactly the same as the frequency of the secondary of the main motor, since, as stated above, the magnetic field of the ohmic drop exciter is rotating in space at one-half of its synchronous speed. At any other speed, the voltage generated is constant and the machine de-

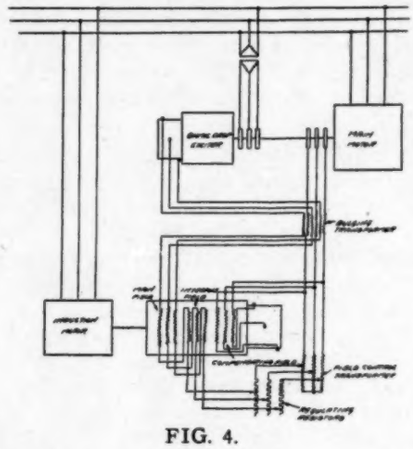

FIG. 4.

livers from its brushes alternating current at a frequency equal to the slip frequency of the motor. It may be noted that alternating current at zero frequency is direct current.

If the armature is driven above synchronism, the magnetic field will, of course, rotate in an opposite direction and the machine will deliver from the brushes, alternating current having a phase rotation reversed from that when operating below synchronism.

The operation of the equipment can best be explained by reference to Fig. 4, which shows the main connections of a Scherbius regulating equipment for the wide speed ranges usually encountered on main roll drives in steel mills. The main field winding is excited at all times at exactly the frequency and phase rotation of the secondary of the main motor. One source of this excitation is the ohmic drop exciter. This exciter provides a source of constant

voltage whose frequency is always exactly that of the voltage at the main motor slip rings. The regulating resistors provide a means of making the resistance drop of the exciting current, required for any desired excitation of the regulating motor, equal to the voltage of the ohmic drop exciter.

The alternations of the flux induce in the exciting winding a voltage proportional to the flux and to its frequency. This voltage is neutralized by introducing into the field circuit the needed fraction of the slip ring voltage of the main induction motor. This is obtained from taps on an auto transformer connected across the slip rings and, like the voltage induced in the exciting field winding, is proportional to the frequency of the main motor, as it is a fixed percentage of the slip ring voltage for any one adjustment. Consequently, this system will maintain a constant excitation on the regulating machine, even though the speed of the main motor should vary (as by a change of load.)

The ohmic drop exciter, therefore, supplies the ohmic drop component of the main field excitation and the field control transformer supplies the reactive component drop. When operating remote from synchronism, the reactive component predominates and the effect of the excitation from the ohmic drop exciter is small as compared to that obtained from the slip rings. When operating near synchronism, the ohmic drop component would predominate and the effect of the excitation from the ohmic drop exciter would be large as compared with that from the slip rings. At synchronism there would be no reactive component and all the excitation (direct current) would be provided by the ohmic drop exciter.

A bulging transformer, whose primaries are connected in series with the slip rings of the main motor and whose secondaries are connected in series with the exciting field winding of the regulating motor, provides a means responsive to the load of shifting the phase of the voltage applied to the main field winding of the regulating motor and hence to the secondary of the main motor. This transformer has a gap in its magnetic circuit and serves to modify the variation of the power factor with the load.

Speed adjustment is obtained by varying the percentage of the main motor slip ring voltage which is obtained from the field control transformer, and suitably adjusting the regulating resistor, thereby changing the excitation and voltage of the regulating motor. For any given setting of the field control transformer, the voltage of the regulating motor is held constant and hence the speed of the main motor is maintained constant except for the inherent slip.

The principles involved in connection with the control of a frequency converter are similar to those described above, with the exception that the frequency converter being connected to a synchronous generator operates at a fixed speed and the function of the regulating set is merely to control the flow of power through the frequency converter set. If an induction motor is driven at constant speed by a synchronous machine and a voltage is applied at the slip rings at a frequency corresponding to the slip frequency, current will flow in the secondary winding which will either cause the motor to develop a torque which will drive the synchronous machine as a generator or will cause the motor to act as a generator. The flow of power through the set, being a function of the voltage applied to the slip rings of the induction motor, is controlled entirely by the voltage obtained from the regulating motor.

In the application of this type of control to frequency converters, there are two conditions which may be encountered and which require somewhat different modification of the control equipment:

The first condition is where the frequency or speed range which must be taken care of by the regulating equipment is small. In this case the reactive component is small. Consequently, the field control transformer can be omitted provided another

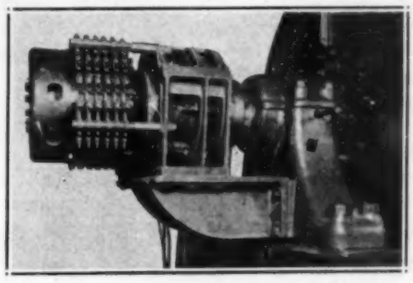

FIG. 5.

means is provided for obtaining voltage control of the regulating motor. This is accomplished by providing the ohmic drop exciter with two sets of brushes which will move in opposite directions, and which will tap off varying proportions of the voltages obtained at the commutator. By changing the relative position of the brushes, as by separating them, placing them together, or separating them in the opposite direction, the voltage taken from the commutator and impressed on the exciting field of the regulating motor will be changed, which in turn would change the voltage impressed on the slip rings of the main induction motor.

The shifting of the brushes on the ohmic drop exciter is accomplished by a pilot motor which is controlled by a contact-making wattmeter or similar device.

Fig. 5 and Fig. 6 show the construction of the ohmic drop exciter of the set shown in Fig. 1. Fig. 5 also shows the brush shifting mechanism, including the pilot motor and speed reducing gear, which is required to obtain a suitable speed for the brush shift.

This type of control permits of a certain amount of adjustment of the automatic variation of the power factor as well as manual power factor control on the induction motor end of the set. This is accomplished by adjusting the phase angle of the voltage of the regulating motor, which can be shifted by controlling the phase angle of the exciting voltage obtained from the ohmic drop exciter and by an additional rheostat controlled power factor field winding.

Automatic control is obtained by means of the bulging transformer described above, which supplies voltage which is proportional to the load and adds at an angle to the voltage supplied to the slip rings of the ohmic drop exciter. Consequently, the phase

of the voltage applied to the slip rings of the ohmic drop exciter shifts automatically with load.

Voltage control for the field of the regulating motor can be obtained by shifting the two sets of brushes on the ohmic drop exciter with respect to each other. Shifting the axis of these sets of brushes as a unit changes the phase angle of the voltage, whereby adjustment of the power factor may be obtained to obtain a satisfactory average characteristic which can be manually adjusted by the power factor rheostat to suit conditions. This control permits raising the overall power factor to approximately unity for any condition within the rated capacity of the set.

The manual control of power factor is obtained by a special winding on the regulating motor which is connected to a separate set of brushes on the ohmic drop exciter so located that the excitation of the power factor field is at a suitable angle to that of the main field. A rheostat in the circuit of this power factor field permits adjustment of this field, so that the phase angle of the regulating motor voltage may be controlled, thereby changing the power factor of the main motor.

Power factor control of the synchronous end of the set may be obtained in the same manner and to the same extent as on any synchronous machine.

The set is started from the induction motor end by means of secondary resistors and automatic control. When the set is up to speed and the regulating set is running, the secondary of the main motor is connected to the regulating motor and the

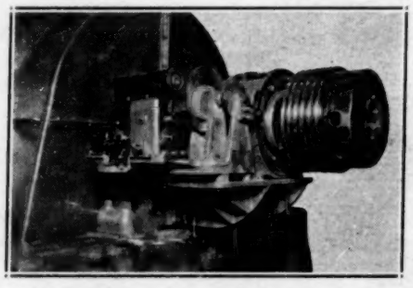

FIG. 6.

starting equipment is cut out. The set is then synchronized on the synchronous end by means of speed control of the induction end. All other switching and control is the same as would be required for a synchronous-synchronous frequency converter set, except that a contact-making wattmeter or similar device is provided, which operates the pilot motor of the brush shifting mechanism on the ohmic drop exciter, thereby controlling the flow of power.

The second condition which may be met is where the frequency or speed range is relatively large. The voltage range which can be taken care of by brush shift on the ohmic drop exciter, as described above, is limited and, consequently, other means must be provided to obtain this increased range. There are many possible ways of doing this, such as connecting a small motor-generator set between the line and the slip rings of the ohmic drop exciter. The voltage control obtainable on the generator of the set would provide a means of varying the voltage applied to the slip rings of the ohmic drop exciter and hence to its commutator and the exciting field of the regulating motor.

Another feasible method would be to connect an induction voltage regulator in the slip ring circuit of the ohmic drop exciter, whereby a control would be obtained similar to that obtained by the motor-generator set mentioned above.

The power transmitted by the regulating set, which is determined by the percentage regulation below or above synchronism, is relatively small compared with the main set. For example, assuming a 6000 KW, 300 RPM frequency converter with a speed range of four per cent above and below synchronism, the approximate size of the regulating set would be:

KW (Reg. Set) = 4% of 6000 = 240 KW

The Scherbius controlled type of frequency converter has two unique operating advantages over other types of frequency converters:

1. It permits tying together two systems having different and varying frequencies under all conditions of frequency, load and voltage.
2. It permits control of the amount and direction of the power flowing between the two systems.

The Scherbius-controlled frequency converter, therefore, is of special interest to the steel mill in its relation to the Central Station and vice versa, inasmuch as it had been considered in the past almost impractical to tie the Steel Mill systems to Central Station systems due to the unstable frequency conditions usually obtained on the Steel Mill systems.

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# Speed Regulating Induction Motor Synchronous Generator Frequency Changer Equipments*

By H. C. UHL†

*My paper is just to be supplementary to Mr. Schwarz's paper and to be primarily a discussion of his paper. It might, however, be well to give you just briefly, as most of you are steel mill men, a little discussion of the Scherbius system as applied to steel mills, and then afterwards explain the various modifications which make it applicable to frequency changer work, which Mr. Schwarz has just presented to you in his paper.*

*The Scherbius equipment was originally an European development and was first built in this country about 13 or 14 years ago. The original Scherbius equipments were single range equipments. By single range we mean that the main induction motor on the mill was operated from synchronous speed down and not above synchronous speed. There was also in these equipments a certain small operating range near synchronism in which it was not possible to operate regulating.*

*The General Electric Company later developed these equipments still further by making the Scherbius equipment operative both above and below synchronous speed with no inactive portion of the speed range near synchronous speed running regulating, that is, perfectly stable operation was then obtained at all speeds in the speed range from minimum speed below synchronism to maximum speed above synchronism including speeds at or near synchronous speed. This was called double range because the induction motor on the mill could then be operated both above and below its synchronous speed.*

*This, of course, was a decided advantage because for a given speed range with the synchronous speed approximately in the middle of the speed range for the double range scheme auxiliary apparatus of approximately one-half the capacity could be used instead of that which would be required for a single range equipment. Also looking at it another way, for a given size of auxiliary equipment, approximately twice as much total speed range could be obtained by the double range scheme over that possible when using the single range scheme.*

*There is, of course, the added advantage in double range equipments in that it is possible to operate at the middle of the speed range, that is, at synchronous speed, rolling a large proportion of the sizes desired, without using the auxiliary apparatus.*

*The development of the double range Scherbius equipment made it possible to broaden the field of application of this system and the results have justified this improvement.*

*A large number of Scherbius equipments are now in service as Mr. Schwarz has mentioned in his paper.*

FIVE large frequency changer equipments of the speed regulating induction-synchronous type have recently been built, (2) for the Rochester Gas & Electric Company and (3) for the Niagara-Lockport and Ontario Power Company. These frequency changers each consist of a 4 pole, 750 RPM, 25 cycle induction motor direct connected to a 10 pole, 720 RPM, 60 cycle synchronous generator. The capacity of each frequency changer equipment is 6000 KW. On the synchronous generator end of the set, a direct connected direct current exciter is mounted, which is used for the excitation of the synchronous generator fields, and on the induction motor end of the set a brush shifting ohmic drop exciter is mounted. A separate regulating set is also used.

The 60 cycle system has a quite constant frequency, while the 25 cycle system has a more variable frequency, usually low. The function of the frequency changer in this particular case is to furnish power at 60 cycles to one system, obtaining the power from another 25 cycle system, and to transfer a constant block of power regardless of the fluctuations on the 25 cycle side. This is particularly useful on large power systems and makes it unnecessary to change the governors of the generating units to continue the flow of power through the frequency changer as the flow of power may be controlled right at the frequency changer.

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*Presented at Cleveland, March, 1926.

As above stated, the flow of power will usually be from the 25 cycle side to the 60 cycle side, but it is possible to also transfer power in the opposite way, using the same equipment.

The usual function of a Scherbius equipment in steel mills is to control the speed so that a variety of sizes or sections may be rolled on a set of rolls with maximum production and uniform quality or to adjust the speed between sets of rolls where the steel is in several mills at one time—i. e., control the loop between mills.

The function of the regulating set in the case of the frequency changer equipment is to merely control the flow of power through the frequency changer set. The speed of the frequency changer set is not changed as it is fixed by the synchronous motor or generator which has a fixed speed, depending upon the frequency. The control of the flow of power is obtained by shifting the brushes of the ohmic drop exciter, which controls the field of the regulating motor. The brushes are shifted by means of a pilot motor, which in turn is controlled by a contact making wattmeter through the necessary contactors. The flow of power through the frequency changer may thus be held approximately constant within the capacity of the regulating equipment. Additional brushes on the ohmic drop exciter provide control for adjusting the power factor by means of a rheostat inserted between these brushes and an exciting winding on the regu-

lating machine, as had already been described by Mr. Schwarz.

Since the variation in frequency in percentage of full frequency is relatively small, the frequency which it is necessary for the regulating motor to handle is quite low and, therefore, it is possible to use a much simpler arrangement for the control of the regulating motor field than obtains on the usual steel mill equipments using regulating sets. In this latter case, the secondary frequency or the frequency that it is necessary for the regulating set to handle is a considerable percentage of full frequency. Since the frequency is low on the frequency changer equipments, it is possible to dispense with the usual reactance balancing component apparatus, as the field control transformer with its controller and contactor panel, and use only the resistance balancing component apparatus, as the ohmic drop exciter with its usual transformer. It may be quite desirable to use a six phase winding from the collectors of the ohmic drop exciter to get the benefit of a better flux distribution or wave shape, but the usual three phase will be taken from the commutator of the ohmic drop exciter.

Since the variation in frequency is quite small, the size of the regulating set is only a very small percentage of the capacity of either member of the frequency changer. On the Rochester Gas & Electric Company's equipments, the frequency changer is of 6000 KW capacity, while the regulating motor is only 300 KVA capacity.

The speed of the synchronous motor is 720 RPM, while the synchronous speed of the induction motor is 750 RPM. The equipment is started up from the induction motor end and comes up to 750 RPM with the synchronous generator idle. The speed is then regulated down on the induction motor from 750 to 720 RPM and the synchronous motor is then phased in. From this point on, the speed regulating set controls the flow of power through the frequency changer set.

Assuming the flow of power to be from the 25 cycle system to the 60 cycle system and the automatic load holding device cut out:

1. If the 60 cycle frequency rises and the 25 cycle frequency does not change, the frequency changer would tend to deliver less power to the 60 cycle system.
2. If the 60 cycle frequency falls and the 25 cycle frequency does not change, the frequency changer would tend to deliver more power to the 60 cycle system.
3. If the 25 cycle frequency rises and the 60 cycle frequency does not change, the frequency changer would tend to deliver more power to the 60 cycle system.
4. If the 25 cycle frequency falls and the 60 cycle frequency does not change, the frequency changer would tend to deliver less power to the 60 cycle system.

Under number 1, in order to keep the flow of power constant, we would adjust the regulating set so that it would tend to speed the induction motor up. Of course, it does not actually speed the induction motor up and, therefore, only controls the flow of power.

Under number 2, in order to keep the flow of power constant, we would adjust the regulating set so that it would tend to slow the induction motor down.

Under number 3, same as number 2.

Under number 4, same as number 1.

The Rochester Gas & Electric Company equipments are designed to take care of full normal load for a fluctuation of 25 cycle frequency from 23.2 cycles full load to 25.4 cycles full load, considering that the 60 cycle frequency remains constant and that the flow of power is from the 25 cycle side to the 60 cycle side. At no load, these values are 23 cycles to 25.1 cycles.

For inverted operation—i. e., flow of power from the 60 cycle side to the 25 cycle side—full load may be taken care of with 60 cycle frequency constant for a fluctuation of the 25 cycle frequency from 22.7 to 24.9 cycles full load. At no load the values will again be 23 cycles to 25.1 cycles.

For normal operation of the equipment, the efficiency and power factor of the equipment will be as follows:

For lowest 25 cycle frequency, the efficiency of the induction motor portion of the set at 720 RPM, with the regulating set operating, will be approximately 94.6%; power factor 99% lagging. For highest 25 cycle frequency, the efficiency of the induction motor portion of the set is approximately 94.3%; power factor 99% lagging.

For inverted operation, these values will be substantially the same, but it would probably be necessary to change the adjustment that controls the power factor to obtain substantially the same power factor.

If the 25 cycle frequency would change sufficiently for the regulating set to operate at a position equivalent to its non-regulating position, the power factor could be adjusted to approximately the same as above mentioned.

Several things are very interesting on these equipments. The primary voltage of the 25 cycle induction motors is 11,000 volts. Since the amount of regulation is quite small, in order to use a standard regulating set it was necessary to use a 5,000 volt secondary on the induction motor. To prevent the 5,000 volts from being generated in the rotor at starting, the stator was connected "Y" for starting and "delta" for running. When up to speed and running, only a very low secondary voltage, of course, exists in the secondary of the induction motor.

In addition to the usual resistance in the secondary of the motor which is cut out by the usual contactor panel with current limit control, a resistance is inserted in the primary before all switching operations—i. e., when throwing the motor on the line and when changing from "Y" to "delta." This is left in the circuit only approximately 2 or 3 seconds, after which it is short circuited. This is to limit any possible surge on the motor.

A synchronizing resistance may also be used in the induction motor secondary during the synchronizing period, after which it can be shorted out by the closing of the 60 cycle circuit breaker.

## GENERAL

With the frequency changer scheme at present developed, it is more advantageous to place the Scherbius equipment on the 25 cycle side rather

than on the 60 cycle side, although it is possible to place the Scherbius equipment on either side.

The capacity of the frequency changer is usually not limited by the regulating equipment as the regulating equipment is usually only a very small percentage of the total capacity and, therefore, the size of either the induction motor or the synchronous generator would determine the limits in size of this scheme.

In regard to the maximum regulation possible, on the present scheme as developed it is always, of course, understood that as much regulation would be obtained as is needed. The particular scheme used, of course, would be determined by the amount of regulation required. With the present scheme, the regulation could be approximately plus or minus 7 to 8% maximum—e.g., 6% above 10% below, approximately full load with 25 cycle Scherbius. Some of the effective speed range, of course, is lost if you use 60 cycle—720 RPM machine, and 25 cycle—750 RPM machine.

Another question which might occur is how close can the frequency changers as built hold the flow of power between systems. On the equipments in service it has been found that if the apparatus is set to hold a flow of power at 6000 KW, it will be possible to hold from 5500 to 6500 KW usually for all ordinary conditions and the equipment takes care of these very nicely. Short, sharp variations are not compensated for instantly as the equipment and mechanism must have time to function.

## DISCUSSION

**O. C. Callow***: I want to say that the papers were very interesting to me with regard to the interchange power, but what we interchange is a little different than this. The remark regarding steel mill frequency being varying and the Central Station frequency being steady, the reverse is prevalent in our case and we have not been able to use regulators on our turbine.

I don't believe I ever heard any one explain the Scherbius system so clearly.

There is one thing I would like to know and that is: how fast that takes care of the variation in frequency? Your frequency in your mill drops down and do you get a flow of power right back through?

**H. C. Uhl**: I might answer that in this way, I mentioned that on some of the equipments installed and operating, the usual variations as met with are of such a nature that the variations in the flow of power will range from 5500 KW to 6500 KW with the regulating devices set for transferring a constant block of 6000 KW. This, of course, means that the ordinary fluctuations are taken care of automatically within quite small limits. The compensating devices are necessarily damped as hunting conditions cannot, of course, be tolerated.

**I. N. Tull†**: I don't know that I can say anything on this subject, but I might ask a question or two. The first one is: how do you back up your power, or how do you invert the flow?

**H. C. Uhl**: The flow of power between the two systems—i. e., the quantity of power—assuming the power flow to be from the 25 cycle system to the 60 cycle system, is a function of the adjustment of the field of the regulating machine of the regulating set, or rather is accomplished by adjusting the brushes on the ohmic drop exciter which supplies this excitation, which adjustment is automatically obtained by adjusting the contact making wattmeter, setting it for the amount of power desired to be transferred.

Now, if you want to invert the flow of power, you would then.

**I. N. Tull**: I thought perhaps you could point it out on your diagram.

**H. C. Uhl**: Yes, I can do that. The various units were referred to on the diagram and their function described when inverting the power flow. By properly adjusting the contact making wattmeter, setting it for inverted flow—i. e., setting it to transfer power from the 60 cycle side to the 25 cycle side—the brushes of the ohmic drop exciter and consequently the field of the regulating machine is adjusted so that the power flow is inverted, first reducing the amount of power transferred from the 25 cycle system to the 60 cycle system and then building it up again in the opposite sense—i. e., building it up so that power is transferred from the 60 cycle system to the 25 cycle system until the amount is transferred corresponding to the setting of the contact making wattmeter.

**I. N. Tull**: Have you any of these in service?

**H. C. Uhl**: Yes, (5) are actually in service: (2) were built for the Rochester Gas & Electric Corporation, Rochester, N. Y., and (3) were built for the Niagara-Lockport & Ontario Power Company.

**D. Martigonne***: I would like to hear more from the Central Station men. I am somewhat disappointed that we did not have more representation from the Central Stations because it looks to me that Mr. Schwarz and Mr. Uhl, through their papers, have shown us that they can get around to selling power to the steel mills. Of course, in the past we all were more or less afraid to tackle this problem on account of speed regulations and also from the point of losses.

I assume (if I am not correct I hope you will correct me) that a set of this kind will have an efficiency of about 90 per cent.

**F. J. Schwarz**: A little higher than that.

**D. Martignone**: A 6000 or a 10,000 KW set will represent a rather heavy loss in transformation, but that loss and also the investment on the set could be compensated by floating these sets on the line, just as Mr. Schwarz mentioned in the opening of his paper, letting the set float on the line. For instance, steel mills are practically shut down on Saturday and Sunday and you would take that power and pump it back into the power company's supply, and you would get a certain revenue. You could make that power cheap and you can sell it cheap. That wouldn't increase your carrying charges.

**G. B. Schneeberger†**: I have little to add, but there is rather a new angle on interchange power

*Chief Elec., Trumbull Cliffs Furnace Co., Warren, O.
†Elec. Engr., McKinney Steel Co., Cleveland, Ohio.

*Sales Rep., General Electric Co., Cleveland, Ohio.

†Elec. Engr., Cleveland Electric Illuminating Co., Cleveland, Ohio.

that I have had in mind regarding the synchronous set between the steel mill and the Central Station, but this system enables you, as I understand it, to hold in a comparatively short range a given block of power—i. e., having an agreement between the steel mill and the Central Station. As I understand it, this is the system that performs that function. As the station becomes tied in with the super-power line, it necessarily means that the frequency is held in very close limits, especially if the station is of any size. In that case the regulating set would be comparatively small, wouldn't it?

**H. C. Uhl:** In the case of the Rochester units, the frequency changer units were 6000 KW capacity, the induction motor being an 8500 HP machine, the regulating machine was only 300 KVA capacity. In the case of the Niagara-Lockport units, the frequency changer units were of the same size as above, but the regulating machines were 500 KVA capacity, the greater capacity being required because they operated under different conditions as to frequency range and because greater power factor improvement was desired.

**G. B. Schneeberger:** Of course, on the face of it, it looks like a complicated system, but as compared with the roll drive, it is comparatively simple.

I don't believe I have anything more to say other than that.

**S. L. Henderson*:** I haven't anything to add of interest or even ask any questions, only I would like to say that I hope that in the future the Central Station men will be after us to give them power and it may expand the use of such equipments.

**A. W. Mohrman†:** I don't know that I can add anything to the paper as far as the power being transferred from the steel mill to the Central Station, but on account of the fact that I am now a steel mill man, in the steel mill business and not an electrician, I don't know as I ought to say a whole lot—in fact, I can't.

About eight or nine years ago, if Mr. Schwarz or Mr. Uhl had come around and explained the Scherbius system as they did tonight, I would have bought him the best cigar in town (laughter). I know that I have stayed up nights and worked Sundays in order to learn all that I could. Mr. Hull has spent many days down there with us and I think the system is working fine, at least it was yesterday when I was down there.

You mentioned that you could transfer the power from the steel mill to the Central Station and also from the Central Station to the steel mill or blast furnace. I would like to know if that can be done with one machine.

I would also like to know whether that machine will automatically take care of that transfer or whether you have to change the control or whether or not you need an attendant to watch these things.

**H. C. Uhl:** In answer to your first question, whether the flow of power may be transferred from the 25 cycle to the 60 cycle system or conversely using the same apparatus, that may be answered "yes." The same apparatus is used. In answer to your second question, it is done automatically. We have a contact making wattmeter, which may be set for a given load and the power flow is held close to this setting regardless of the frequency fluctuations. This is adjustable and may be set for various values. In other words, if you want 2000 KW transfer instead of 6000 KW transfer of power from one syst to the other, you simply change the adjustment or setting.

**A. W. Mohrman:** We will assume that we are rolling some steel in the mill where I am located (and I think Mr. Martignone knows a lot about the conditions we have there), and perhaps this steel is 600 or 800 feet long, using a consumption of power all the way from 3000 KW to 6000 KW for a duration of 17 seconds and the acceleration of that power is, from no load to full load, perhaps about 9 seconds, and the falling off of that load is a little more than that—say, about 11 seconds—would this set, assuming that before this load went on, giving power to the Central Station, and this load obtained through that interval was such to pull the voltage down on the steel mill side, draw enough power from the Central Station to hold that voltage and frequency up so as to keep the mill from dying down and stretching and cobbling, and all of that trouble?

**H. C. Uhl:** The use of these frequency changers is for the purpose of transferring power between two systems, the steel mill system and the Central Station system, and the steel mill, of course, has its own generating capacity which is relatively large as compared to the capacity of an individual unit and in case of extreme fluctuations of rolling mill load especially for short passes flywheels are used. Do you have flywheels?

**A. W. Mohrman:** No, sir.

**H. C. Uhl:** Then your mill power system must take the whole bump. If you had a frequency changer there the flow of power would be held at approximately a constant value, depending upon the setting made and would not be a function of the amount that the frequency changes. If you have a system, such as you mention, the voltage and frequency fluctuation depends upon your mill system and the power transfer is not affected—i. e., the block of power would still be transferred to or from the Central Station system. If you were drawing power from the Central Station system, the power transfer would still continue practically constant without much fluctuation if the frequency variation was not too rapid. If the fluctuations are extremely violent, it would take a little time for the apparatus to function and greater fluctuations in the power transfer may result.

**A. W. Mohrman:** For instance, in the cast of the power house, as it sometimes happens in a steel mill, they build a power house and put in a turbine, or two of them, of 4000 or 5000 KW. Suppose they put in a power house of this kind and then along in two years or so they will alter the mill and they don't have the money to put in another power plant, but the alterations have caused just a little overload. Then they will put on another little mill and it loads up the power house more; nevertheless the machine in the power house will hold it down, but the boiler house will not take care of it, and the steam goes down, such as it does in the case where I am, and naturally one of us has to shut down.

In a case like that would a frequency changer of a certain size be better on a system of that kind,

*Elec. Supt., Central Furnaces., A. S. & W. Co., Cleveland, Ohio.

†Engr., Trumbull Steel Co., Warren, Ohio.

or would it be better to put in another turbine and build the boilers to take up that excess load?

There is another question. When we are not using all of those machines or when the mill is not running, there is perhaps just as much gas burned as there was before and if the power house before was operating as if it had 10,000 KW and we were only using 6000 KW, it is logical that we were giving out 3000 or 4000 KW to the Central Station and when the mills are running we would need that 10,000 KW and would this frequency changer automatically function there and take the power from the Central Station? In other words, is it a put and take system?

**H. C. Uhl:** It, of course, depends upon the arrangement you could make with the Central Station. It seems to me, in answering the question, if you did not wish to increase the capacity of the generating system in the mill, it might be an advantage to put in a frequency changer to secure a block of power from the Central Station and use that in times of your large power demand and pump back into the Central Station system at the times you have excess power.

**I. N. Tull:** I suppose you could arrange a service set to limit power both ways, could you not?

**H. C. Uhl:** Yes, the contact making wattmeter could be adjusted.

**I. N. Tull:** If you had a 6000 KW frequency changer, you could limit it to 8000 KW, couldn't you?

**H. C. Uhl:** That could be arranged in the overload relays.

That would have to be determined by the amount of power you have available and the frequency changer set would have to be designed to take care of the peak you wanted. I can see no reason why it could not be limited and why you can't control the flow, because if it is set for 6000 KW it will give you between 5500 KW and 6500 KW for any normal frequency variations.

**I. N. Tull:** Is it a fact that the induction-synchronous set would be more flexible and less liable to damage.

**H. C. Uhl:** You get a cushioning effect. In other words, if you use the induction-synchronous equipment, you get a more flexible tie in.

**I. N. Tull:** You couldn't do such a thing on a synchronous-synchronous type.

**H. C. Uhl:** The variations of frequency would actually change the amount of power transfer, and there is nothing you could do to adjust it other than change the governing devices on the power generators. In this set you can adjust the amount of power and hold it automatically.

**D. Martignone:** Do I understand, Mr. Schwarz, the new design of the frequency changer you can build, you are able to build them at 750 RPM rather than 300 RPM or, in other words, it would give you 62½ cycles?

**F. J. Schwarz:** The regulating set takes care of it.

**E. E. Gifford, Jr.*:** Mr. Chairman, I think you have heard enough from the General Electric Company already, but there is a point that I am not quite clear on. As I understand this outfit here, of the five outfits we have sold, we adjust this set to hold a certain definite load—i. e., in the case of the five we sold we try to hold these sets to furnish a definite amount of power, or 6000 KW, from a 25 cycle to a 60 cycle unit, for instance. Now you say this is a give and take proposition. How can you set your contact making wattmeter to keep that interchanging power constant at the 6000 KW and give and take? I would think that you would have to have that give and take proposition. I would not think you would want to have the output 6000 KW, because that amount would vary from 6000 KW down to zero.

**H. C. Uhl:** The Central Station doesn't like to get the bump from the steel mill and, therefore, they like to transfer a block of power to the steel mill?

**E. E. Gifford:** Yes.

**H. C. Uhl:** That is a question that has to be worked out. They would prefer to transfer a block of power either way.

**E. E. Gifford:** That is, the Central Stations would be receiving the block of power from the steel mill, but the steel mill would want a give and take proposition, and you say this will take care of it automatically, but how will you take care of it with that machine?

**H. C. Uhl:** You know how the ordinary contact making wattmeter operates. It is a sort of floating device and follows in this case the power transfer in definite kilowatts.

**E. E. Gifford:** Now suppose that you don't want definite kilowatts?

**H. C. Uhl:** You would have to use another device.

**E. E. Gifford:** I mean—

**H. C. Uhl:** You mean instead of taking a constant block of power, to make it the other way around and have the frequency changer take the fluctuations, don't you?

**E. E. Gifford:** Yes.

**H. C. Uhl:** That hasn't been worked out because in the case of some of the systems, the 25 cycle system is largely hydro-electric and the 60 cycle system is largely steam, and there is available an excess of power on the 25 cycle system and they prefer to transfer a whole block of it to the 60 cycle side and the fluctuations and the variations in demand is taken care of by shutting down or putting on turbines. Does that answer your question?

**E. E. Gifford:** Yes.

**F. J. Schwarz:** The idea of the contact making wattmeter is to fix the amount of power delivered by the frequency changer, as I explained in my paper, and the idea was to deliver a certain amount of power. For instance, on Saturdays and Sundays, when the mill is shut down, you would deliver a certain amount of power to the Central Station and during the week the Central Station would deliver a fixed block of power to the steel mill and not take care of any fluctuations. We haven't figured on any set to take care of the bumps.

**S. L. Henderson:** I gather from this last remark that we can get only certain amounts of power; this is limited by the watt meter relay. Is that the situation?

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*Sales Engr., General Electric Co., Cleveland, Ohio.

**H. C. Uhl:** If your conditions are that way, you have to provide for these conditions.

**S. L. Henderson:** If that is true, there must be some unloading done; therefore, some part of the mill suffers for power. As I gather from the information, if the set is 6000 KW. a reasonable amount of overload can be carried up to the limit set by the watt meter and beyond that the overload peaks must be absorbed by other generating equipment.

**F. J. Schwarz:** This frequency set is an additional power unit, the same as a turbine and you may make a different setting of the wattmeter to take care of that additional power within the capacity of the frequency changer set. If you are to take care of the bumps you have to put in a set large enough to take care of those bumps.

**S. L. Henderson:** Of course, as you know, there are power conditions in the steel mill that come on very suddenly, therefore these must be met by sufficient generating capacity.

**F. J. Schwarz:** In other words, you can't expect any more from the frequency set than from the turbine.

**S. L. Henderson:** Then I take it that after the load reaches a certain point, either the steel mill must relieve the situation or the relays will act on the set and trip it out. Is that true?

**H. C. Uhl:** What I thought you meant was, when you are transferring a constant block of power, then suppose your steel mill demands would go down, then you would still transfer a constant block of power, then your governors on your mill generating units would function so that they would cut the load down on your generators in the steel mill. When the load would come on again, the governors would then move and it would generate the excess power for the extra load conditions.

**O. C. Callow:** In the case of the turbine which is to be tied in to the power company's main, and to be regulated by the steam pressure in the boiler house, or, in other words, when the steam drops down, you then cut back into the machine, and if you have the tie-in, you don't automatically take care of the condition. You see, we are running that way and we have that condition, for we have a 5000 KW turbine tied in and we maintain a constant steam pressure by cutting the load as the steam drops. Now, if we have to cut into a 25 cycle instead of a 60 cycle, we would have to cut back.

**H. C. Uhl:** I don't know that I just quite understand your question, but are you operating your turbine and do you have an excess amount of power that you want to transfer back to the Central Station and you also have a fluctuating demand.

**O. C. Callow:** No, the turbine is supplying power to the company all of the time.

**H. C. Uhl:** Then if you can maintain a frequency and control the frequency over a given range and don't have a fluctuating load—

**O. C. Callow:** The load will vary all the time you are always cutting the load up and down.

**H. C. Uhl:** You would vary the amount of power; is that right?

**O. C. Callow:** Yes.

**H. C. Uhl:** Then you are introducing two regulating functions. You are introducing it on your turbine and also on the frequency changer. That is another set of conditions which you have to take into consideration. You are regulating the load on your turbine and have the contact making wattmeter set to transfer a block of power. You would have to adjust the wattmeter to take care of a particular load condition and if you want to transfer a different block of power, you would have to change it.

**O. C. Callow:** In our case we would have to be changing it all the time.

**H. C. Uhl:** The conditions so far that we have had to meet are not the conditions that you bring out.

**O. C. Callow:** The synchronous-synchronous converter would work better on this.

**H. C. Uhl:** In a case like that, I can't see the advantage of the adjustable tie in.

**S. L. Henderson:** I would like to ask Mr. Callow if he has ever attempted to do that regulating that he speaks of when his steam pressure goes down, to do that automatically, that is, reduce the load by some automatic regulation?

**O. C. Callow:** No, we haven't.

**F. J. Schwarz:** He might regulate the wattmeter and control the flow of power. We have not yet considered any such special control features.

**O. C. Callow:** If we had a 25 cycle side instead of a 60 cycle side, we could, but we don't use it at all. I just wondered how it would work out.

**H. C. Uhl:** You may also note that it is not necessary to tie in a 25 cycle system with a 60 cycle system, but you may desire to tie in with a 50 cycle system and properly proportion the speeds of the various units.

There is also another point that I didn't mention and that is whether you could use the Kraemer system for frequency changer work. It is possible to use the Kraemer system and also other systems in various modifications. In the Kraemer system, however, the capacity of the auxiliary equipment would have to be made larger than in the system as now developed.

# *Utilizing Waste Fire Bricks*

By J. A. FAULKNER*

IN writing an article of this kind for practical men to read, we do not believe anything will be gained by generalizing on the subject.

To say that waste fire bricks can and are being used is only saying what everybody interested in the refractory end of engineering knows and is doing to a certain extent every day.

What the busy man wants to know is what have you got and what are you doing with it? And possibly who is doing it?

Our method was developed more or less from necessity. The writer, through different stages of

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advancement, finally found himself engineer in charge of the boiler room of the largest steam power plant in the country. One of the greatest problems he had to confront was to keep the walls and arches of eighty-six big boilers intact, while they were being run at ratings and efficiencies unthought of years ago.

Plastic fire clay was being used for laying up fire bricks, the results were the same as most plants obtain by using fire clay in high temperatures. There is practically no bonding or tensile strength in fire clay, and while some will stand the temperature demanded of them, they will not stand the erosion effects. No matter how much care is taken in laying up a wall or arch with fire clay, sooner or later the clay will disintegrate or burn out, allowing an opening to occur between the bricks through which the hot gases pass and attack five sides of the brick instead of one and eventually wreck the wall, and during this slow process of wrecking the wall, a great deal of the heat that should be used in the furnace has radiated through the openings to the outside wall and helped to disintegrate that also.

There is only one kind of a wall to expose to a hot fire and that is a perfectly straight, smooth tight wall where the joints are as good or better than the bricks so that the bricks can be bedded and no openings, be they ever so small, allowed to occur. When I say this, I do not mean in what is termed the hot zone only, but in the entire setting. How often have we climbed into the top of a high setting and found the clay dried out from between the bricks and the wall loose. Allowances must be made, of course, for a certain expansion and contraction, but the wall in general must be laid tight. The recognition of this fact has not only encouraged the fire brick manufacturers to make a more uniform brick to effect a closer joint, but has influenced a large majority of the same brick makers who, a few years ago told us that all we needed was their bricks and the same plastic clay their bricks were partly composed of, to make a perfectly good fire wall, and who frowned on all makes of high temperature cement on the market, to place on the market themselves a high temperature cement of some name or other, to offer for sale in place of plastic fire clay.

It is not our intention to criticise any endeavor to improve furnace conditions. The high temperature cement manufacturers have done some wonderful work and should be given credit. We believe it is for the individual plant engineer to work out his own problems. Our problem was that while we were trying in every way to improve our conditions and paying big prices for material to do it with, we were, at the same time, throwing away each month, or oftener, a solid car of brick bats, and these, as we then thought, have proved to be very valuable refractory material. The worst of it was we were paying the railroad to haul them to the dump. I do not think anyone questions the value of calcined bats, provided, of course, they are not contaminated.

We experimented with the limited knowledge we had of refractories with these brick bats. We broke them up with a maul and mixed them with high temperature cement. This did not get us anywhere, the expense was greater than new brick work. We had bricks pulverized in a mill and where this is a little improvement, it is not much better. In order to make the right kind of plastic mortar with any amount of tensile strength from old bats, a wet pan of some kind must be used so that the mortar can be mixed and mulled in the wet state and made ready to use. We had our troubles to determine what wet pan to use, in our hunt we found that very few wet pans are adaptable for this particular kind of work. We finally prevailed upon the Hadfield-Penfield Steel Co. to remodel their standard American wet pan to make it a complete grinding, mixing and mulling machine. With the machine in place we were ready to start. Everybody about the place had an idea about what should be done; we had our own, and we tried them all. Did you ever get an idea in your head that you had something you were sure was right and everything was set for a big killing and at the end of six or seven months you checked up and found you were way out of balance? It is surprising how many things you can find wrong when you start to check up on your own work.

To make a satisfactory mortar, one of the first things to determine is if the mixture is complete. If you ever try to make mortar in a wet pan and want to check up on your mixture, throw a cupful of red powder in the pan with the other ingredients. You can soon tell if you have a complete mix or a streaky one by the look of the mass after a few revolutions of the pan. We had to make some alterations in the mixing arrangements of the wet pan that have since been adopted as standard for this work. What goes into the mixture is very important, in fact, the most important item to be considered. Ground calcined brick dust is an important item to be considered. Ground calcined brick dust is an inert quantity. Something must be added to make it plastic, add tensile strength and make it stand the stress put upon it without squashing out of the joints. The addition to the ground brick must be of the same general characteristics as the brick so that the joint has practically the same co-efficient of expansion and contraction as the bricks themselves. The first thought is plastic fire clay and from the standpoint of first cost and low temperatures, it is the most satisfactory ingredient to use, but we are working for improved walls without additional cost as the first consideration. The joint, in our opinion, should be stronger than the brick. It is necessarily thinner than the brick and is more easily destroyed by the ravagings of the fire.

We know that plastic fire clay, in the majority of cases, has a lower fusing point than flint clay. With few exceptions, a fire brick is composed of a large percentage of flint clay and a smaller percentage of plastic clay. When we grind our brick bats we already have this plastic clay, inert from being burned in our brick dust, adding more plastic clay simply dilutes the high refractory qualities of the original clay from which the brick was made. Another point is that in making a joint as we do, a considerable part of the mortar adheres to the bricks and is ground the second and each successive time that the bats are used for making mortar, by the continued use of plastic clay with the old bats and mortar, eventually the mortar will become useless. This same applies where sodium silicate or any high temperature cement containing sodium silicate or any salts are used for the initial set.

The addition of calcined brick dust to plastic clay will without doubt improve fire clay, but the

same mixture does not improve the refractory qualities of the ground fire brick. The engineer who thinks he has gone the limit when he has ground his brick bats and plastic fire clay together to make high refractory mortar, plastic brick or material for facing his walls, has a big surprise coming to him if he digs deep enough.

It would not be fair to our company, nor do we think the readers of this article would expect us to describe what we finally developed by the combination and special treatment of several brands of flint clays, without the use of sodium silicate or other salts, to make a bond that gives to brick dust all the required essentials to make a good mortar that air sets, and at the same time raises the fusion point rather than lower it. Our bond is easily procured, if you care to experiment with it. If care is exercised in selecting the bricks to be ground and a binder of as high quality as the bricks is used to make the mortar, any sized joint can be made with safety, no cutting need be done, simply even up the courses and carry a straight smooth wall with no fear of the bricks being irregular, and no necessity of rubbing the bricks together to get a tight joint. The high temperature cement question is answered for the plants adopting this method, and in no case that we know of does it cost more than $10.00 to produce a ton of this mortar including labor.

At the Standard Oil Co. of Ohio, for their oil stills and boiler furnaces, and at the A. M. Byers Co., of Girard, Ohio, in heating and puddle furnaces, they have adopted a regular ⅝" joint. In this way they save every fifth course of bricks or 20 per cent, and an additional 8 per cent on the vertical joint.

The saving of 28 per cent of new bricks that cost $15.00 a ton and using ground brick mortar at less than $10.00 per ton to replace them together with improved walls that last from 15 per cent to 20 per cent longer, shows a nice interest on the investment for equipment.

There is much to be said for and against plastic brick for patching, and coating walls by hand or by air pressure; this is a different story. We only have this to say at this time. If any plant is interested in these methods, there is no reason why they cannot make plastic material of their own bricks if they have the proper equipment.

It has been the writer's experience, not only in the boiler room mentioned above, but in possibly one hundred boiler and industrial plants, where we have put our methods in operation, that a wall properly laid up with ground brick mortar needs very little repair, it stays until burned out. From observation and experience we do not know of anything, with the exception of better and more careful designing, that has improved fire brick work without material increase in cost, than ground brick mortar.

Most of our remarks have been regarding power plant work, we believe the same methods can be applied to any fire brick work.

# *Items of Interest*

The Roller-Smith Company, 233 Broadway, New York City, announces the following changes in its sales agencies:

The States of Maryland, Virginia and North Carolina, formerly covered by J. E. Perkins, Baltimore, are now covered by C. R. Speaker, Evening Star Building, Washington, D. C. These States, plus the District of Columbia, comprises Mr. Speaker's present territory.

The Tennessee Engineering and Sales Company, Tennessee General Bldg., Knoxville, Tenn., have had added to its territory the States of Georgia, Florida and South Carolina, which, together with Eastern Tennessee, form the section in which they represent the Roller-Smith Company.

The former arrangement with W. A. McCombs & Co., Westinghouse Bldg., Pittsburgh, Pa., has been transferred to a newly-formed organization, the D-C Sales Engineering Company, at the same address. The personnel of the new organization comprises Mr. T. M. Cluley and Mr. G. S. Danithorne. Mr. Cluley, as Manager of W. A. McCombs, has been identified with the Roller-Smith interests in the Pittsburgh section for several years. Mr. Denithorne and Mr. Cluley have had many interests in common for some time past and those interests have brought Mr. Denithorne closely in touch with the R-S lines. The consolidation of their interests, resulting in the formation of the D-C Sales Engineering Company, will give the Roller-Smith Company excellent representation in the Pittsburgh section.

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The Ohio Electric & Controller Co., Cleveland, O., wish to announce the appointment of the following representatives:

Railway Power & Engineering Corp., Ltd., 133 Eastern Avenue, Toronto, Ontario.

The Industrial Supply Co., Brown-Marx Bldg., Birmingham, Ala.

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Edwin L. Wiegand Co., of Pittsburgh, electrical heating engineers and manufacturers of Chromalox heating units, announce that W. Hunter Snead, former publicity division manager of the Detroit District Office of Westinghouse Electric & Mfg. Co., has recently become their advertising and sales promotion manager.

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The Brown Instrument Co., Philadelphia, Pa., has issued a very attractive catalogue containing 80 pages of descriptive matter, which is of interest to every Engineer using pyrometers for the accurate and efficient measurement of high temperatures. This catalogue is known as No. 15 and will be mailed upon application.

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R. F. Fiske, for several years manager of the R. D. Nuttall Co.,'s Eastern office at Philadelphia, has

been appointed sales manager in place of L. W. Hershey. John E. Mullen, of the home office sales force, has been made assistant sales manager.

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Mr. L. L. Brastow, Sales Manager, The Trumbull Electric Mfg. Co., Plainville, Conn., announces the appointment of Mr. H. S. Hill, as Sales Representative of the Southern district headquarters in Atlanta.

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The Nichols Lintern Co., of Cleveland, O., announces the appointment of Mr. George C. Towle of Philadelphia, as their Eastern Pennsylvania District Manager, headquarters Philadelphia, Pa., for the distribution of N-L Universal Lanterns and The Lintern Electro Magnetic Sanders.

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The American Engineering Standards Committee announces the formation of the International Organization for Standardization. It is the intention of the International Standards Association that its work shall include the approval of International Standards and the administrative machinery setup is so designed that it may be readily extended or modified to include the approval of such International Standards when sufficient experience has been required.

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The Graybar Electric Company announces the proposed opening of three additional branches to be located at the following cities: Reading, Pa., Dayton, O., and Hartford, Conn. It is expected that these new branches will be in operation in the spring.

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The General Electric Company has issued three attractive pamphlets which may be had upon application, covering Wound Rotor Induction Motors, G-E Squirrel Cage Motors and G-E General Purpose Synchronous Motors.

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The Freyn Engineering Co. has instituted an innovation in the publication of a house organ called "Freyn Design." Volume 1, April, 1926, No. 1 is a handsome booklet illustrating the achievements of the Freyn Engineering Co. "Making Iron with Utah Ore and Coal," by W. R. Phibbs, General Superintendent, Columbia Steel Corp., Harrington, Utah, is a very interesting article. "Electric Roll Heater Facts," by Gordon Fox, indicates the trend of the times in Sheet and Tin Mills in connection with preheating Sheet and Tin Mill Rolls. An article covering the progress at Central Furnace, in connection with the erection of a 600-ton Blast Furnace, is also very interesting. "Blast Furnace Capacity," by Frederick H. Wilcox, claims the tonnage capacity of the new Blast Furnace is dependent upon too many factors to permit a strictly accurate estimate to be made; for instance,when plant design is undertaken the engineer and operator do not know the character of ore or of coke that will be imposed on the operation frequently not even for the first blast. Another very interesting article is the "Utilization of Waste Heat for Steam Generation at the Melrose Park Plant of the National Malleable and Steel Casting Co.," by A. N. Conarroe, Chief Chemist, National Malleable and Steel Casting Co.

The Freyn Engineering Co., is to be congratulated upon the first appearance of their new publication.

The Cutter Electrical and Manufacturing Co., of Philadelphia, announces the removal of its New York office from 1170 Broadway, to 12 East Forty-first stret, New York City (just off the Avenue), new telephone numbers Murrayhill 8145 8146.

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The Clark Controller Co, Cleveland, O., has issued four illustrated bulletins covering their Flexible Couplings, Clark Three C Brakes, Screw Jack Dead Ending Clamps and Clark Manual Controllers.

Bulletin No. 100 describes the Clark Manual Controllers, which are of improved face plate type built for heavy duty service, suitable for Overhead Electric Traveling Cranes, Charging Machines, Mill Tables or any application where reversing of the motor is necessary and where hand operation is suitable. Bulletin No. 101 describes the Screw Jack Dead Ending Clamps for Standard Cable. These clamps are of the single-barrel and double-barrel type. Bulletin No. 102 contains a complete description of the Clark Three C Magnetic Brake series, or shunt wound, direct current; the Three C Brake introduces a new operating principle in so far as this class of apparatus is concerned. The double-gear sector arrangement permits the use of a split friction band, which utilizes practically 90 per cent of the circumference of the Brake Wheel, and which is equally efficient in each direction of rotation. Bulletin No. 103 introduces the Clark Flexible Couplings—no bolts, no screws, no oil, no grease. The Clark Flexible Coupling is the result of quite a number of years of study and operation in regular Steel Mill service. These couplings are operating successfully in connection with motors driving reversing Mill Tables, Pumps, Compressors, Cupola Blowers and many other applications in the Steel Industry. The Clark Flexible Coupling can be universally applied to any direct connected load starting with fractional horse power motor drives and reaching up to and including the operation of large rolling mills. An interesting feature in connection with the construction of this coupling is the small number of parts required for a complete coupling. One sleeve, two hubs, two keeper rings, two spring retaining and eight pieces of packing are all that is required. The operation of the coupling consists of the driving hub rotating, causing its four projecting teeth to press against four of the pieces of packing.. This pressure is transmitted to the four inwardly projecting teeth on sleeve. These teeth extend across to the other hub and transmit the pressure to the teeth on the driven hub, through the other four pieces of packing. It may be noted that the packing is in compression. All shear strain is taken by heavy steel section. It is not necessary to move the motor nor the driven apparatus to remove the armature of motor. Simply take out spring retaining ring and keeper ring, slide sleeve back over other hub as shown above, remove the pieces of packing, armature, shaft and hub may be lifted vertically.

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The April issue of the Trumbull Cheer contains an article of general interest, the subject of which is "Salesman of the Second Line." This article is exceptionally interesting, one paragraph of which we desire to quote: "This proposition of salesmanship lies in activity—the home, the club, the neighborhood, the society—everything. Consciously or un-

consciously, we are salesmen and the job we have is to sell ourselves, our families, our business, our communities, to those who come within our reach."

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The Wellman-Seaver-Morgan Co., Cleveland, O., has issued a new Bulletin No. 85, descriptive of the latest W-S-M Mechanical Gas Producer. This bulletin contains information relating to gas analysis, coals and comparison of fuels.

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The Thompson Electric Co., Cleveland, O., has issued a bulletin No. B-26, describing a Safety Lowering Switch or disconnecting hanger. The Thompson Safety Lowering Switch or Hanger solves the lamp cleaning problem, because it enables the work to be done with ease and safety down on the ground —no climbing hazards—no electrical hazards, as the lamp is lowered away from the electrical circuit for the cleaning process.

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The Pittsburgh Transformer Company, Pittsburgh, Pa., has issued a bulletin No. 2053, which describes some advantages of Pittsburgh Polyphase Distribution Transformers. This transformer was invented and developed by Pittsburgh Transformer Engineers and it drew attention to and emphasized the advantages of three-phase transformers. Bulletin No. 2053 may be had upon application. Bulletin No. 2052, issued by the same company, describes distribution transformers, single phase and polyphase, copies of which may be had on request.

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M. H. Detrick Co., 140 South Dearborn street Chicago, Ill., has just issued a very attractive 16-page booklet covering the Detrick Sectional supported walls. This wall construction is a distinct departure from anything that has been offered previously and is a new and superior type of interlining for use on hollow wall type, pulverized fuel furnaces. Each individual section of refractory tile, whose dimensions, as viewed from the interior of the furnace, are approximately 30″x10½″, is supported independently of every other like section, both vertically and horizontally, by cast iron hanger bar.

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A complete reorganization of the sales department, involving the reallocating of the managing personnel and the creating of several new activities, has been announced by E. D. Kilburn, vice president and general sales manager of the Westinghouse Electric and Manufacturing Company, effective April 1.

The change, which involves all departmental sales managers of the company, consists of the following apointments: Assistant to vice president, E. H. Sniffin, formerly manager, Power Department; director of sales, T. J. Pace, formerly manager, Supply Department; Central Station manager, G. H. Froebel, formerly manager, Marine Department; industrial sales manager, J. M. Curtin, formerly Industrial Department; transportation sales manager, M. B. Lambert, formerly manager, Railway Department; assistant director of sales, A. C. Streamer, formerly assistant to manager, Supply Department; generating apparatus manager. H. W. Smith, formerly general engineer; traction apparatus manager, A. J. Manson, formerly manager Heavy Traction Division, Railway Department; motor apparatus manager, O. F. Stroman, formerly assistant to manager, Industrial Deartment; switchgear apparatus manager, R. A. Neal, formerly head of Switch Section, Supply Department, and distribution apparatus manager, G. A. Sawin, formerly assistant to manager, Supply Department.

The announcement is the culmination of a reorganization of the Westinghouse sales system which has been in course of development for some time. Its effect, according to Mr. Kilburn, will be to form a more flexible organization now necessary to serve and anticipate the needs of electrical apparatus users, due to the tremendous development of the industry.

Mr. Sniffin, newly appointed assistant to Vice President, became prominent as commercial aid to George Westinghouse, founder of the Westinghouse companies. He is one of three men who were directly responsible for the introduction of the steam turbine to the United States. His career with the company dates from his sixteenth year, when he became a stenographer in the New York offices of the Westinghouse Church Kerr & Co., who were, at the time, sole agents for the Westinghouse Machine Company. By studying mechanical engineering in his spare time, he became a salesman of power plant equipment at the age of 22. In 1900 he was made sales manager of the company he had joined as a stenographer and three years later was appointed sales manager of the Westinghouse Machine Company. In 1906 he was made vice president in charge of sales for the company ,and in 1915, when the Electric company absorbed it, was made manager of the Power Sales Department.

The new director of sales, Mr. Pace, is a native of Pittston, Pa., but received his first business experience in New York City, when, at the age of 20 years, he joined a contracting firm there. In 1899 he was engaged by the Manhattan General Construction Company, of Newark, N. J., which, at the time, was owned by George Westinghouse. During the latter part of the three years Mr. Pace was with the Manhattan Company, he held the position of assistant to general manager. In 1902, when the Manhattan Company was purchased by the Westinghouse Electric Company, Mr. Pace moved to East Pittsburgh, where he was given charge of illuminating apparatus in the Detail and Supply Correspondence Department. Three years later he was made manager of what was termed the illuminating and rectifier sections. In 1915, Mr. Pace was made assistant to manager of the Supply Sales Department, an outgrowth of the former Detail and Supply Department. Five years later he was made assistant manager of his department, a position he held in 1922, when he was appointed manager.

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The selection and application of centrifugal pumps to mine pumping is the subject of a 20-page leaflet, distributed by the De Laval Steam Turbine Co., of Trenton, N. J. Instructions are given for the design of piping, and the calculation of friction head power required. Details of construction which should be looked into when selecting pumps for this service, are also discussed at length. This publication should be useful not only to mine owners and engineers, but to anyone using pumps for irrigation, general water supply, and similar service.

# IRON AND STEEL EXPOSITION

**June 7-10th, 1926** **Hotel Sherman** **Chicago, Ill.**

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Morgan Engineering Company
Electrical Engineers Equipment Company
V. V. Fittings Company
National Carbon Company, Inc.
Baker Raulang Company
Robinson Ventilating Company
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The Electric Storage Battery Company
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